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By

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Abstract

In this paper we analyse the performance of fixed interest managed funds. We examine the relative effectiveness of seven different indices of bond performance, some commercially available and some that we construct ourselves as explanators of Australian fixed interest managed fund returns. We combine these measures with four different measures of interest rate fluctuations, four measures of economic fundamentals, two measures of maturity risk, two measures of default risk, and two measures of equity market returns in an attempt to find an 'optimum' index for benchmarking Australian fixed interest managed fund returns. We run our tests over two independent periods in an effort to identify (in a consistent setting) the most accurate and least biased methodology. The use of an Australian dataset, sourced from the Australian fund-rating agency ASSIRT means that we can provide some independent results from previous US studies, as there is little prior work on Australian fixed-interest managed funds. We apply a two-pass (time-series and cross-sectional) analysis to capture the different information content benchmarks carry in these two dimensions. Our research method involves test of combinations of factors and benchmarks in both dimensions and a search for the most parsimonious optimum benchmark factor combination (in terms of explanatory power in both dimensions). The results, consistent across time, show that a correct combination of a bond market variable, a mixture of interest rate factors and economic factors as well as the proxy for movements in the equity markets yield the optimal benchmark.

Keywords: Performance benchmarking; fixed interest managed funds

JEL Classification: G10; G12; G24

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1. Introduction

The significant upsurge in the share of financial markets claimed by the managed funds sector in recent years has highlighted a need for an effective performance benchmark. In this paper we analyse a number of combinations of benchmarks suitable benchmarking fixed interest funds.

Previous studies of various types of funds have produced a wide range of results even when using similar methodologies or similar benchmarks. Lehman and Modest (1987) and Grinblatt and Titman (1994) examined an array of possible models and benchmarks, finding that the choice of a performance measure and the reference benchmark can have a profound influence on the excess returns observed for managed funds. Robson (1986) came to similar conclusions in a study using Australian data. Some 30 years prior, Friend et al. (1970) cautioned "against using a benchmark that effectively tricks the alpha calculation by overweighting [certain] returns", thus highlighting the issue of a 'fair' benchmark definition (Ippolito, 1993).

During the quest for discovery of this 'fair' benchmark, researchers have developed a vast array of specifications. These include the 8-Portfolio benchmark proposed by Grinblatt and Titman (1989) which is based on known relationships between returns factors and firm characteristics. An alternative proposal was put forth by Ferson and Schadt (1996). The argued that excess returns derived from use of public information should not be recognised in the performance alpha, they developed a conditional expectations model for the benchmark construction. In this paper we have set out to analyse a set of benchmarks for fixed interest funds with a view to assessing their comparative results as well as their individual efficiencies. Using the ASSIRT database on Australian managed funds we were able to mitigate any data mining bias, ensuring an objective assessment of theories tested herein most of which were developed from US data. Furthermore we were able to provide an international perspective on the managed funds performance from a unique financial market. To control for several unique characteristics associated with new funds and funds nearing their demise, we have subdivided our sample period into two five-year time frames between 1990 and 1999. This also allows us to perform a number of inter-temporal analyses of our results.

The remainder of this paper is organised as follows. Section 2 describes the methodology including model and benchmark definitions, followed by Section 3 that describes the data set. Section 4 presents the results. Section 5 concludes.

2. Methodology

2.1 Performance Measures

2.1.1 Standard Market Model

The starting point of this analysis is the standard Capital Asset Pricing Model (CAPM), which advocates a linear relationship between the excess returns on a specific fund or a portfolio, and the excess returns on a market proxy:

$$r_{i,t} = \alpha_i + \beta_i r_{m,t} + \varepsilon_{i,t} \tag{1}$$

where $r_{i,t}$ is the excess return (the raw return minus the risk free rate) on fund i in the month t; α_i represents the abnormal performance of the fund i; β_i represents the beta risk of fund i; rm,t is a measure of excess returns on the benchmark market index and $\varepsilon_{i,t}$ is the error term with expected characteristics of a white noise (such as a mean of zero).

Our definitions of the market returns proxy include the All Ordinaries Index, and a 500 stock Value-Weighted Index.

Since many writers including Fama and French (1996) and Carhart (1997) strongly argue that the influence on fund returns does not arise from a single source only, the next logical extension to this model is to allow for construction of the benchmark using multiple factors. To this end we reformulate the above model, substituting the single-index market proxy ($r_{m,t}$) for a vector of factors $\Omega_{BM,t}$.

$$r_{i,t} = \alpha_i + \beta_i \times \Omega_{BM,t} + \varepsilon_{i,t} \tag{2}$$

Our multifactor proxies include factors designed to capture the effects of interest rate fluctuations, term spreads, default spreads, and GDP growth.

2.1.2 All Ordinaries Index

The All Ordinaries Index is a value-weighted index tracking top firms listed on the Australian Stock Exchange. Inherent in its definition is a bias towards small number of large, well-established companies, which may bring to question its applicability as a general market proxy.

2.1.3 Value Weighted Index

This index corresponds to a strategy, which invests funds in all market stocks in proportion to their capitalisation. As such it also affords more importance to large firms, but covers a broader cross section than the All Ordinaries Index. Our construction of this benchmark is one of an open-ended index, which thus eliminates any survivorship bias and non-trading bias.

$$VWIdx_{t+1} = VWIdx_t \times \left\{ \sum_{i=1}^{N_t} \left[\frac{MV_{i,t}}{\sum_{j=1}^{N_t} \left(MV_{j,t} \right)} \times \left(\frac{P_{i,t+1}}{P_{i,t}} - 1 \right) \right] + 1 \right\} \tag{3}$$

2.2 Regression Analysis

The regression of every fund in every time frame for every model against every benchmark and every factor was finally performed. This afforded us a set of results with unprecedented level of detail and gave us the ability to authoritatively test the excess return in each category for the null hypothesis of zero mean. It also gave us a detailed sample in which we could run a series of analyses in time series and cross section of the relative explanatory power of different benchmark/factor combinations and undertake statistical analysis of the optimum (most parsimonious) combinations.

Furthermore, the construction of tests as described above are potentially afflicted by the problem of heteroscedasticity. To account for this we report our t-values adjusted using White's (1980) heteroscedasticity correction algorithm.

2.3 Explanatory Power of Benchmark Factors

In specifying an appropriate performance measurement model, due consideration must be given to the trade-off between the model's ability to explain variance in assets' returns, and its parsimony aimed at improving forecasting accuracy. The first step in the process of forming a new performance measure is therefore a study of the explanatory power contained in each benchmark specification. In this context it is important to recognise the two-dimensional nature of benchmark information – the ability to explain *temporal* changes in return series and the capacity to explain cross-sectional returns variations *across* individual funds. As previously specified, we account for this by adopting a two-pass test methodology, first examining each of these dimensions separately and then forming conclusions on the basis of joint results.

Initially we examine the explanatory quality of indices *within* each category. Since the incremental information can have a compounding effect in explaining fund returns as we add more factors into a benchmark, we compute *all* benchmarks comprising *all* combinations of one through to *n* factors, where *n* is the total number of factors in the given category. For the *aggregate bond returns* category (see above), for example, this resulted in 127 benchmarks, seven of which were in one-factor group, twenty-one in two-factor group through to one benchmark comprising all seven factors[1]. Time series for these benchmarks are regressed against each fund in the sample, producing a sequence of regression coefficients and additional statistics such as the adjusted-R^2 values. Armed with these results we then set out to examine the explanatory power of different factors and factor combinations in temporal as well as APT sense[2].

Our time-series methodology involves detailed examination of R^2 and adjusted-R^2 statistics resulting from the above regressions[3]. We analyse these results on three independent levels. First, we examine the *average* explanatory power offered by groups with different number of factors, thus creating an $n \times n$ matrix of t-statistics and p-values. Second, we conduct an F-test of a joint hypothesis that the explanatory power equals amongst benchmarks with a *given* number of factors, thus reflecting on the substitutability of factors. Third, we formulate an $m \times m$ matrix of t-statistics and p-values, where m is the total number of benchmarks defined for a given category[4]. This permits us to look at the differential explanatory power of individual pairs of factor compilations. If the factors are perfect substitutes, information content for any combination should not only be identical relative to each other, but also to each factor individually.

In the cross-sectional analysis we develop two separate tests. First test looks at the proportion of cross-sectional variation explained by each benchmark using methodology that improvises on Elton, Gruber and Blake (1995), summarised in equation (4).

$$R_t^2 = 1 - \frac{\sum_{i=1}^{n}\left(r_{i,t} - r_{i,t}^{e}\right)^2}{\sum_{i=1}^{n}\left(r_{i,t} - \bar{r}_t\right)^2} \qquad (4)$$

We define the unexplained return for each fund at each point in time as the difference between realized return, $r_{i,t}$, and the expected return from equation (2), r_e. Next we record the R^2 from the regression of realised returns on the unexplained returns. This is the proportion of variation *not* explained by the benchmark. Taking one minus this figure therefore gives me the proportion of cross-sectional variation explained by the factors in the benchmark. Unlike the results in Elton et al. (1995), our formulation of R^2 as a time-series based on cross-sectional stacks allows us to attribute a significance level to each mean as well as to comparison of means between alternative benchmarks. Armed with such data, we then perform the same three-level analysis as for the time-series.

The second test of cross-sectional data determines individual contribution by each factor towards the overall estimation of fund returns, with methodology based on equations (5A) and (5B).

$$w_{\langle k|BM\rangle,j} = \frac{\beta_{k,j} \times \bar{r}_{k,j}}{\sum_{i=1}^{n} \beta_{i,j} \times \bar{r}_{i,j}} \tag{5A}$$

$$\bar{w}_{\langle k|BM\rangle} = \frac{w_{\langle k|BM\rangle,j}}{\sum_{j=1}^{S} w_{\langle k|BM\rangle,j}} \tag{5B}$$

The weight w for each factor k forming a part of benchmark BM is defined as the proportional product of factor coefficient β and the average return $\bar{r}$ on that factor over the regression time frame (*eq* 5A). Weights are first calculated for every firm j to permit computation of the series variance and hence the significance level attributed to the average weight $\bar{w}_{\langle k|BM\rangle}$ (*eq* 5B)[5]. In line with our hypothesis, if n factors are perfect substitutes then each should contribute $^1/_n$ towards the formation of returns expectation.

An outcome of this two-pass analysis recommends the 'preferred' factor(s) chosen from each category based on its (their) joint contribution towards explaining temporal and cross-sectional variation of returns. In this decision, consideration is given to the trade-off between model's explanatory power improved by adding more factors, and its parsimony characterised by fewer factors. Consequently, given a statistically insignificant difference between the information content of two alternative factor groups, the group with fewer factors is preferred. The methodology is then reapplied to *all* benchmark combinations formed from the preferred factors. An outcome of this final two-pass test is the recommendation for a benchmark that uses the fewest number of factors to achieve the maximum explanatory power in both dimensions of fund returns[6].

As a test of robustness, mean and variance of residuals from regressing realised fund returns on this benchmark were finally tested. If a benchmark is, in fact, informative and without an apparent lack of other critical factors, then the distribution of these residuals should approximate white noise.

All of the above analyses are conducted in both periods specified in this study, to also affirm the robustness of this performance measure definition across time.

3. Data: Performance Measures of Fixed Interest Managed Funds

3.1 Managed Funds Sample

The data on managed fixed-interest funds used in this study were sourced from the ASSIRT Library, a detailed database covering the Australian managed funds market compiled by ASSIRT rating agency. Our tests of explanatory power analyses improvise on the methodology applied by Elton, Gruber and Blake (1995) in their study of US bond funds.

Before allowing a fund to enter our sample for a particular time period, we apply one additional filter. Since computation of several benchmark factors is specific to the Australian market, we peruse the actual asset allocations of every fund classified as *interest bearing* [ASSIRT code *IB*], and approve only those funds, which principally invest in Australian fixed interest securities. This results in 168 funds entering our sample in the first period and 537 funds in the second.

In process of reconstructing a new benchmark we restrict the temporal analysis to only two periods: 1990-1994 and 1995-1999. The rationale behind excluding the first period (1985-1989) lies in the increased impact of the self-selection bias as the number of participating funds decreases. Our preliminary studies also indicate that the profile of managed fund characteristics changes dynamically from their inception through to their demise. The time partitions help to mitigate the influence of such changes.

The bulk of our model data was sourced from the Datastream database compiled by Primark, cross-checked (and when necessary, supplemented) by the Australian Stock Exchange electronic data requests.

Testing data over a continuous time frame undoubtedly raises the possibility of a survivorship bias. In the context of managed bond funds this issue was examined by Blake, Elton and Gruber (1993) who noted that survivorship bias is less important for bond funds than it is for stock funds since bond fund performance is less variable and, consequently, fewer funds merge or dissolve. They conducted several comparative tests marking the extent of such bias at approximately 27 basis points per year in the positive direction. Through a series of empirical simulations Brown, Goetzman, Ibbotson and Ross (1992) also studied the extent of survivorship bias, finding it to significantly impact on the strength of returns predictability, but not on the fundamental conclusions about abnormal performance as reported in Goetzman and Ibbotson (1991) and Patel, Hendricks and Zeckhauser (1991). Interestingly, Patel et al. (1991) take up this issue in the published version of their working paper to which Brown et al. (1992) refer. They analyse sub-samples designed to induce survivorship bias and conclude that "survivor bias appears unimportant" for studying mutual fund performance. Nevertheless, to account further for the effect survivor selection may introduce, we have taken two additional steps. First, we have examined the attrition rate defined as the percentage of funds that disappear from the sample due to non-survival relative to the total number of funds extant during the reference period. We found that non-surviving funds accounted for only 2.8% to 5.3% of all eligible funds in each period. Based on simulations conducted by Brown et al. (1992), such cut-off rate would not produce bias that would significantly invalidate observed abnormal returns. Second, we have reformulated the sample to remove the effect of non-survivors, by following through each demised fund and adopting the standard reinvestment assumption where the investor is presumed to distribute his or her capital proportionately across the remaining funds from the month of termination. Alternatively this process may be likened to an investor randomly selecting a fund from the surviving population.

3.1.1 Australian Bond Benchmark Factors

The monthly return series for the UBS Warburg Composite Bond Index, Salomon Smith Barney WGBI Index, JP Morgan Bond Return and the JP Morgan Bond Price Index were taken from the Datastream database and are based on reports from the financial institutions that compile the respective indices. The Datastream All Maturities Bond Index is formed by Primark Corporation and represents a composite of bond yields covering the full spectrum of maturities, also reported through the Datastream channel. The Value Weighted Index and the Equally Weighted Index of managed fixed-interest fund returns were computed from the monthly return series contained in the ASSIRT Library compiled and distributed by the ASSIRT Rating agency.

All of the interest rate and yield series, including the 90-Day Treasury note rates, 10-Year Government bond rates and the composite Datastream indices of government bond yields from different maturity segments, were downloaded from the Datastream database.

This source was also used to obtain monthly information on Australian inflation position, and the quarterly Gross Domestic Product (GDP) reports. To concur with our monthly frequency requirement, we have interpolated official GDP figures to fill the intra-quarter estimates under the assumption of progressive growth from one quarter to the next. In addition, all GDP series have undergone an orthogonality transformation against inflation data to highlight their differential information content.

The remaining two bond indices, the Lehman Brothers High Yield index and the WDR index of Asset Backed Securities, were extracted from the Datastream reproducing the series compiled by the two financial institutions. The All Ordinaries Accumulation Index was also sourced from the same database and cross-checked with reports from the Australian Stock Exchange (ASX).

3.1.2 US Benchmark Factors

Following communications with investment banks and financial institutions compiling the industry indices of aggregate bond performance regarding the consistency of index definitions across different financial markets, we are confident in pairing the UBS Warburg Composite Bond Index, Salomon Smith Barney WGBI Index, JP Morgan Bond Return Index and the JP Morgan Bond Price Index with their respective US counterparts[7]. In the same spirit we match up the Datastream All Maturities Bond Index with its corresponding US series. All of these variables were sourced directly from the Datastream database. Our formulations of the Equally Weighted Index and the value Weighted Index also remain consistent with the Australian definitions (see above), except the sample from which these variables are computed now includes US fixed interest securities instead of bond funds. The basic return series used in these computations were downloaded from Datastream. We reconfirm the insignificant impact of self-selection bias through comparative analysis of statistics derived from restricted (via self-exclusion) and unrestricted indices[8].

In compiling our US interest rate and yield variables, we have paired 90-Day Treasury note rates and 10-Year government bond rates with the 13-Week Treasury bill rates and 10-Year US Treasury benchmark bond yields, respectively. We also adopt the direct US counterparts for the Datastream series of government bond yields from different maturity segments.

We use the Datastream database to source information on monthly inflation rates and quarterly Gross Domestic Product (GDP) figures for the US economy. In a method mirroring the Australian data, we convert GDP figures into monthly series via linear intra-quarter extrapolation, and subject all resulting return variables to an orthogonality transformation[9].

The last of two commercial indices concentrating on the quality spectrum of bonds, the Lehman Brothers High Yield index and the WDR index of Asset Backed Securities were also matched up with their respective US series provided on the Datastream. The All Ordinaries Accumulation Index and the 500 value Weighted index were paired with the Dow Jones and S&P500 indices, respectively.

3.1.3 Equity Benchmark Factors

The monthly returns of the All Ordinaries index were sourced directly from the Datastream database based on reports from the Australian Stock Exchange (ASX).

The Value-weighted index was calculated using prices and market values of all stocks listed on the ASX during the sample period and recorded on the Datastream database.

4. Results of Model Analysis for Fixed Interest Managed Funds

The first step in the path to discovery of an optimal performance measure for fixed income managed funds is to find the right benchmark. A benchmark that appears to be objective may be so not because it provides true reflection on fund performance, but precisely because it has such a poor explanatory power, that its 'excess returns' approximately follow a random walk. For this reason, the foundation step taken in this part of the analysis is to first find a benchmark that is informative, and only *then* progress on to further tests of objectivity and on model formulation.

The literature demonstrates disagreement between recommendations of various authors examining the benchmarking of fixed income securities or fixed income managed funds. Sorting through the array of factor candidates on the basis of their suggestions helps to provide a first round of cautions against factors that are not likely to have a significant contribution to the performance measure, and highlight an early indication of the preferred benchmark.

4.1 Formulating an Informative Benchmark

In searching for a benchmark that is both informative and parsimonious we start by reviewing the information content of factors within each category. Winners from each category are then earmarked for selection into the final round where the preferred factors across all categories are tested. In examining the information content of the benchmark factors we look at both, the ability to explain temporal as well as cross - sectional variations in the returns series. This test is also carried out in two time frames, the 1990-94 period and the 1995-99 period to ensure the consistency of results across time.

4.2 Factors Representing Aggregate Bond Market Returns

Table 1 presents a summary of results derived from the information efficiency tests carried out with factors representing aggregate bond market returns. Panels A1 and A2 of this table present the time-series explanatory power for the 1990-94 and 1995-99 periods, respectively, while Panels B1 and B2 explain the data in cross section for the same two periods.

Focusing first on the *average* explanatory power offered by the market benchmark in the time series sense as presented in the first half of Panels A1 and A2, similarities and distinctions can be immediately drawn between the two periods. The information content increases relatively uniformly from an average of 64.4% in 1990-94 (60.2% in 1995-99) when only a single factor is used, to a peak of 77.8% in 1990-94 (82.9% in 1995-99) when all factors are combined. The variability in the goodness of fit of individual combinations *within* each level (i.e. given a number of factors) varies substantially between the two periods. The F-Test shows that the increment in 1990-94 is relatively uniform across the combinations with the test statistics approximating unity at all levels. This can be also confirmed in the matrix of level differences showing the only significant *average* difference to exist between the first (one factor) and the last (all factor) levels. The R^2 progression is different in the later and larger sample, which exhibits significant differences in the explanatory power of various factors combinations, even when the number of factors is given. This is supported by an F-Test statistic that is significant at a 1% level for all levels. Given this finding of factor non-substitutability it is therefore important to identify which factor(s) perform the best.

Turning attention to the individual performances, consistent dominance of the indices based on managed funds themselves can be found, edging their commercial counterparts based on asset returns by between 1.2% and (significant) 15.2% in the two periods. In the later sample all differences are statistically significant, providing the reason behind the significant intra-level variability highlighted by the F-Test previously. More importantly though, it is only the fund based indices that are also statistically insignificant from the peak R^2 recording a drop off ranging from 5.3% for the value weighted index, down to around

Table 1: Two-Pass Analysis of Factors Representing Aggregate Bond Market Returns

Presented is a summary of statistics resulting from the two-pass analysis of the seven factors chosen in this study to proxy the movements of the bond market. Results from temporal tests, presented in Panels A1 and A2 for the two periods, are derived from R^2 values of time series regressions $r_{i,t} = \alpha_i + \beta_i \times \Omega_{BM,t} + \varepsilon_{i,t}$. Cross sectional data, summarised in Panels B1 and B2, are based on cross-sectional stack regressions defined as $R_t^2 = 1 - \frac{\sum_{i=1}^{n}\left(r_{i,t} - r^e_{i,t}\right)^2}{\sum_{i=1}^{n}\left(r_{i,t} - \bar{r}_t\right)^2}$. Performing these computations against each fund separately rather than against an *average* of fund returns creates a *series* of results, whose average can then be tested with appropriate statistical significances. Each panel comprises several sections. First section is based on average explanatory power attributable to combinations of *n*-factors and thus reflects the incremental benefit derived from adding more independent variables. Whilst the last column presents the group averages together with an F-Test results of benchmark substitutability, the first set of columns relay a comparative matrix. Second section of each panel shows the individual performance of each benchmark, as well as a comparison to the maximum R^2 obtained when all benchmarks are combined. This reflects on how well the more parsimonious combination of factors is able to perform against a peak that is achieved by non-parsimonious inclusion of every factor in the category. Finally, the third section present in cross-sectional Panels B1 and B2 show the relative strength of individual factors when they are combined into a multi-factor benchmark.

PANEL A1: Tests of Time-Series Variance (1990-1994)

	T-Test of Difference in Group Means						F-Test of
Category†	1F	2F	3F	4F	5F	6F	Grp Means
1F							0.644
							(0.920 ^{E*})
2F	0.031						0.675
	(0.634)						(0.955 ^{E**})
3F	0.059	0.027					0.702
	(0.371)	(0.677)					(0.991 ^{E***})
4F	0.083	0.051	0.024				0.726
	(0.208)	(0.435)	(0.715)				(0.999 ^{E***})
5F	0.103	0.072	0.044	0.020			0.746
	(0.119)	(0.279)	(0.504)	(0.761)			(1.000 ^{E***})
6F	0.120^{D*}	0.088	0.061	0.037	0.017		0.763
	(0.070)	(0.182)	(0.357)	(0.577)	(0.800)		(0.989 ^{E***})
7F	0.135^{D**}	0.104	0.076	0.052	0.032	0.015	0.778
	(0.043)	(0.120)	(0.253)	(0.435)	(0.633)	(0.822)	(N/A)

	T-Test of Difference in Means of Benchmark Pairs						
Factor‡	VW_1	EW_2	DS_3	$UBSW_4$	SSB_5	$JPMR_6$	All Factors
VW_1							-0.053
							(0.136)
EW_2	0.015						-0.042
	(0.644)						(0.209)
DS_3	-0.019	-0.034					-0.076^{D**}
	(0.567)	(0.302)					(0.023)
$UBSW_4$	-0.012	-0.027	0.007				-0.059^{D*}
	(0.721)	(0.416)	(0.831)				(0.094)
SSB_5	-0.020	-0.035	-0.001^{E**}	-0.008			-0.077^{D**}
	(0.549)	(0.290)	(0.979)	(0.811)			(0.021)
$JPMRI_6$	-0.020	-0.036	-0.002^{E**}	-0.009	-0.001^{E**}		-0.077^{D**}
	(0.531)	(0.278)	(0.957)	(0.790)	(0.979)		(0.020)
$JPMPI_7$	-0.017	-0.033	0.001^{E**}	-0.006	0.002^{E*}	0.003^{E*}	-0.074^{D**}
	(0.594)	(0.321)	(0.969)	(0.862)	(0.948)	(0.927)	(0.025)

†Corresponds to groups of benchmarks incorporating one through to seven factors.
‡ VW_1 and EW_2 refer to the Value Weighted Index and Equally Weighted Indices of Managed Bond Fund Returns, DS_3 refers to the Datastream All Maturities Bond Index, $UBSW_4$ to the UBS Warburg Composite Index of government, semi-government and corporate fixed interest securities, SSB_5 to the Salomon Smith Barney Government Bond Index, $JPMR_6$ and $JPMR_7$ to the JP Morgan Bond Return Index and the JP Morgan Bond Price Index, respectively.

PANEL A2: Tests of Time-Series Variance (1995-1999)

Category	1F	2F	3F	4F	5F	6F	F-Test of Grp Means
	T-Test of Difference in Group Means						
1F							0.602
							(0.016^{D***})
2F	0.044						0.676
	(0.195)						(0.008^{D***})
3F	0.125^{D***}	0.051					0.727
	(0.000)	(0.136)					(0.001^{D***})
4F	0.165^{D***}	0.091^{D***}	0.039				0.766
	(0.000)	(0.010)	(0.269)				(0.003^{D***})
5F	0.195^{D***}	0.121^{D***}	0.060	0.030			0.797
	(0.000)	(0.001)	(0.103)	(0.405)			(0.013^{D***})
6F	0.216^{D***}	0.142^{D***}	0.091^{D**}	0.051	0.021		0.818
	(0.000)	(0.000)	(0.012)	(0.162)	(0.572)		(0.985^{E***})
7F	0.227^{D***}	0.153^{D***}	0.102^{D***}	0.062^{D*}	0.032	0.011	0.829
	(0.000)	(0.000)	(0.005)	(0.090)	(0.389)	(0.767)	(N/A)

Factor	VW_1	EW_2	DS_3	$UBSW_4$	SSB_5	$JPMR_6$	All Factors
	T-Test of Difference in Means of Benchmark Pairs						
VW_1							-0.053
							(0.193)
EW_2	0.025						-0.028
	(0.531)						(0.326)
DS_3	-0.122^{D***}	-0.147^{D***}					-0.175^{D***}
	(0.001)	(0.000)					(0.003)
$UBSW_4$	-0.119^{D***}	-0.144^{D***}	0.003^{E*}				-0.172^{D***}
	(0.002)	(0.000)	(0.946)				(0.006)
SSB_5	-0.124^{D***}	-0.149^{D***}	-0.002^{E*}	-0.005			-0.177^{D***}
	(0.001)	(0.000)	(0.949)	(0.895)			(0.003)
$JPMRI_6$	-0.128^{D***}	-0.152^{D***}	-0.006	-0.008	-0.003^{E*}		-0.180^{D***}
	(0.001)	(0.000)	(0.877)	(0.824)	(0.929)		(0.002)
$JPMPI_7$	-0.120^{D***}	-0.144^{D***}	0.002^{E**}	0.000^{E***}	0.005	0.008	-0.172^{D***}
	(0.002)	(0.000)	(0.951)	(0.995)	(0.899)	(0.829)	(0.005)

PANEL A3: Tests of Time-Series Variance <u>Ex</u> Managed Fund Indices (1995-1999)

Category	1F	2F	3F	4F	F-Test of Grp Means
	T-Test of Difference in Group Means				
1F					0.631^{E***}
					(0.999)
2F	-0.008				0.640^{E***}
	(0.815)				(0.999)
3F	-0.017	-0.009			0.649^{E***}
	(0.626)	(0.800)			(0.999)
4F	-0.027	-0.019	-0.009		0.658^{E***}
	(0.451)	(0.603)	(0.790)		(0.981)
5F	-0.036	-0.028	-0.019	-0.009	0.668
	(0.309)	(0.433)	(0.595)	(0.791)	(N/A)

	DS_1	$UBSW_2$	SSB_3	$JPMR_4$	$JPMP_5$
	T-Test of Difference in Means of Benchmark Pairs				
All Factors	-0.036	-0.033	-0.038	-0.041	-0.034
	(0.318)	(0.354)	(0.287)	(0.247)	(0.349)

PANEL B1: Tests of Cross-Sectional Variance (1990-1994)

Category	1F	2F	3F	4F	5F	6F	F-Test of Grp Means
	T-Test of Difference in Group Means						
1F							0.535
							(1.000^{E***})
2F	0.067						0.602
	(0.385)						(0.533)
3F	0.122	0.055					0.658
	(0.117)	(0.477)					(0.196)
4F	0.175^{D**}	0.109	0.053				0.711
	(0.027)	(0.170)	(0.504)				(0.292)
5F	0.228^{D***}	0.162^{D**}	0.106	0.053			0.764
	(0.005)	(0.046)	(0.190)	(0.516)			(0.667)
6F	0.280^{D***}	0.213^{D***}	0.158^{D*}	0.105	0.052		0.816
	(0.001)	(0.010)	(0.056)	(0.208)	(0.538)		(0.848)
7F	0.329^{D***}	0.262^{D***}	0.207^{D**}	0.154^{D*}	0.101	0.049	0.864
	(0.000)	(0.002)	(0.015)	(0.071)	(0.242)	(0.576)	(N/A)

Factor	VW_1	EW_2	DS_3	$UBSW_4$	SSB_5	$JPMR_6$	All Factors
	T-Test of Difference in Means of Benchmark Pairs						
VW_1							-0.316^{D**}
							(0.012)
EW_2	0.008^{S*}						-0.308^{D**}
	(0.922)						(0.021)
DS_3	-0.020	-0.028					-0.336^{D***}
	(0.806)	(0.719)					(0.005)
$UBSW_4$	-0.020	-0.028	-0.000^{S***}				-0.335^{D***}
	(0.811)	(0.726)	(0.998)				(0.005)
SSB_5	-0.026	-0.034	-0.006^{S*}	-0.006^{S*}			-0.341^{D***}
	(0.760)	(0.676)	(0.943)	(0.942)			(0.002)
$JPMRI_6$	-0.018	-0.026	0.002^{S**}	0.002^{S**}	0.007^{S*}		-0.334^{D***}
	(0.826)	(0.740)	(0.981)	(0.984)	(0.926)		(0.006)
$JPMPI_7$	-0.017	-0.025	0.003^{S**}	0.003^{S**}	0.008^{S*}	0.001^{S***}	-0.333^{D***}
	(0.834)	(0.748)	(0.972)	(0.975)	(0.917)	(0.991)	(0.006)

Combination	VW_1	EW_2	DS_3	$UBSW_4$	SSB_5	$JPMR_6$	$JPMP_7$
	Analysis of Estimated Returns Contribution						
All Factors	0.3%	93.6%	2.2%	0.2%	0.2%	0.7%	2.8%
All Fund	3.4%	96.6%					
All Bond			14.9%	29.5%	2.9%	22.5%	30.2%
$f_6 + f_7$						21.9%	78.1%
$f_4 + f_7$				77.6%			22.4%
$f_1 + f_4$	82.0%			18.0%			

PANEL B2: Tests of Cross-Sectional Variance (1995-1999)

Category	T-Test of Difference in Group Means						F-Test of Grp Means
	1F	2F	3F	4F	5F	6F	
1F							0.468^{E**}
							(0.957)
2F	0.107						0.575^{D***}
	(0.117)						(0.000)
3F	0.177^{D***}	0.071					0.645^{D***}
	(0.006)	(0.266)					(0.000)
4F	0.232^{D***}	0.126^{D*}	0.055				0.700^{D***}
	(0.000)	(0.054)	(0.404)				(0.001)
5F	0.279^{D***}	0.172^{D***}	0.101	0.046			0.747
	(0.000)	(0.010)	(0.131)	(0.496)			(0.731)
6F	0.317^{D***}	0.210^{D***}	0.140^{D**}	0.085	0.038		0.785^{E***}
	(0.000)	(0.002)	(0.041)	(0.221)	(0.586)		(0.998)
7F	0.348^{D***}	0.241^{D***}	0.170^{D**}	0.115^{D*}	0.069	0.030	0.815
	(0.000)	(0.000)	(0.014)	(0.099)	(0.330)	(0.669)	(N/A)

Factor	T-Test of Difference in Means of Benchmark Pairs						All Factors
	VW_1	EW_2	DS_3	$UBSW_4$	SSB_5	$JPMR_6$	
VW_1							-0.177^{D**}
							(0.033)
EW_2	0.007						-0.160^{D*}
	(0.857)						(0.071)
DS_3	-0.025	-0.032					-0.203^{D***}
	(0.512)	(0.392)					(0.005)
$UBSW_4$	-0.024	-0.031	0.001^{S**}				-0.201^{D***}
	(0.540)	(0.417)	(0.968)				(0.004)
SSB_5	-0.022	-0.029	0.003^{S*}	0.002^{S**}			-0.199^{D***}
	(0.571)	(0.445)	(0.928)	(0.961)			(0.009)
$JPMRI_6$	-0.023	-0.031	0.002^{S**}	0.000^{S***}	-0.002^{S**}		-0.201^{D***}
	(0.547)	(0.424)	(0.962)	(0.994)	(0.967)		(0.005)
$JPMPI_7$	-0.023	-0.030	0.002^{S**}	0.000^{S***}	-0.001^{S**}	0.000^{S***}	-0.201^{D***}
	(0.545)	(0.422)	(0.958)	(0.990)	(0.970)	(0.996)	(0.005)

Combination	Analysis of Estimated Returns Contribution						
	VW_1	EW_2	DS_3	$UBSW_4$	SSB_5	$JPMR_6$	$JPMP_7$
All Factors	2.2%	89.9%	2.6%	0.0%	1.2%	1.5%	2.6%
All Fund	2.9%	97.1%					
All Bond			17.4%	27.7%	9.7%	17.2%	28.0%
$f_6 + f_7$						35.4%	64.6%
$f_4 + f_7$				69.2%			30.8%
$f_1 + f_4$	85.3%			14.7%			

2.8% for the equally weighted index. Also the difference between these two indices is not deemed statistically significant (gap of 1.5% and 2.5% for the two periods), the equally weighted index does show an early lead.

To provide a balanced view for the above analysis that is dominated by the fund based indices particularly in 1995-99, we re-examine the sphere of only the commercial indices built on fixed interest asset returns in Panel A3. It can be noted that the average R^2 now edges up only marginally as extra indices are added, from a low of 63.1% for single factors to peak of 66.8% for all factors combined. F-Test statistics again demonstrate low variability and hence a high degree of substitutability within each level, consistent with the 1990-94 period. This is further confirmed by the level comparison matrix lacking any significant differences, and cemented by the review of individual factors relative to the peak R^2 (now formed only from this restricted base of indices), all of which now show insignificant differences.

Whilst preference for the fund based equally weighted index can be formed from the time series analysis, due attention must be first given to the cross-sectional results before any firm conclusion can be drawn.

A pattern similar to that observed in temporal analysis can be seen as the substitutability of factor combination is more pronounced in the earlier of the two samples. However, in the cross sectional results such difference is only restricted to groups of two to four factors, with *adjacent* levels showing insignificant difference across both time frames. The increase in cross sectional R^2 is dramatic averaging at 53.5% (46.8%) in 1990-94 (1995-99) for single factors, and growing to a peak of 86.4% (81.5%) for all factors combined[10]. Reviewing the individual performances of bond market indices, the fund-based indices again perform the best relative to their commercial counterparts based on the performance of fixed interest assets themselves, although the differences are relatively small. It is, however, only the equally weighted index of managed fund returns that is able to approach the peak R^2 with a difference that is statistically insignificant in 1995-99 and marginally significant in 1990-94. In contrast, all commercial based indices drop off from the peak to degree that is significant at a 1% level in both periods.

A further comparative test is achieved by looking at the relative *contributions* of individual indices, when they are jointly regressed against managed fund returns, presented in the third section of Panels B1 and B2. Reviewing first all seven idiocies together, dominance of the equally weighted fund index becomes clear when it singularly contributes between 89.9% and 93.6% of the total R^2. The DataStream Index and the JP Morgan Price Index come next on similar footing, followed by the remaining indices. Concentrating on fund indices only, equal weighting of returns proves superior over value weighting when it contributes around 97% of the information content. As equal weighting places greater emphasis on smaller funds compared to weighting by value, analysing the importance of these funds may be a valuable exercise in future research. Focusing next on the commercial indices only, a joint lead is taken by the UBS Warburg Composite Index and the JP Morgan Price Index, followed by a joint second taken by the DataStream Index and the JP Morgan Returns Index. Contrasting the two JP Morgan Indices in the next row (f_6 and f_7) clearly highlights the preference for price-based formulation of this index. To break the tie between the two leading commercial indices we have separated their contributory power to a joint pair index. Fourth row (f_4 and f_7) presents the results, which unequivocally highlight the UBS Warburg Index as the preferred bond-based factor choice. This is not surprising as this is the only index that is a composite of government, semi-government and commercial fixed interest instruments, a spectrum likely to be invested in by the managed funds. Finally we set the equally weighted fund based index head-to-head with the UBS Warburg index, re-confirming the preference for the former. Once again this is not unexpected not only from a statistical perspective, but also from the investment perspective where funds would be selective in terms of both, the sub-group of fixed interest instruments they choose, and other instruments they invest in aside from their primary objective.

Reviewing the above results, both information dimensions point to the same factor representing the aggregate market movement as the preferred choice. The Equally Weighted Fund Index not only provides explanatory power across time and cross section that is insignificantly different from the peak of joint R^2, but also dominates the other indices when teamed up in joint regression tests.

4.3 Factors Representing Interest Rate Fluctuations

The analysis of information content inherent in interest rates is presented in Table 2, below. A two by two matrix of factors was tested. In one dimension factors were subdivided according to the horizon over which interest rates are measured, ranging from 90-day Treasury Note rates (TNR) to a composite index of government bonds with one to three year maturities compiled by DataStream (DSGBI). In the other dimension these factors were classified according to whether they captured rate movements at spot, or with a lag (Γ) to allow market time for absorption of change information.

Table 2: Two-Pass Analysis of Factors Representing Interest Rate Fluctuations

Results in this table reflect the explanatory power inherent in factors representing interest rate fluctuations. The derivation of the R^2 values follows the methodology detailed previously. Panels A1 and A2 represent time based information content for the 1990-94 and 1995-99 samples, respectively. Panels B1 and B2 convey the results from cross-sectional tests for the same two periods. First section of each panel looks at the average explanatory power given a number of constituting factors, thus reflecting the average incremental information contributed by addition of more factors. Statistics attached to the group means in the last column are the results of F-Tests of joint equality of means at each factor quantity level. Section two focuses on individual variables or combinations thereof and provides not only comparative results, but also evaluation against the peak R^2 achieved when all factors are joint in a single benchmark. Third section in cross sectional test shows individual contributions of factors when combined into a multi-factor benchmark.

PANEL A1: Tests of Time Series Variance (1990-1994)

	T-Test of Difference in Group Means			F-Test of
Category	1F	2F	3F	Group Means
1F				0.034
				(0.649)
2F	0.130^{D***}			0.164^{D***}
	(0.000)			(0.000)
3F	0.255^{D***}	0.125^{D***}		0.289^{D***}
	(0.000)	(0.000)		(0.000)
4F	0.334^{D***}	0.204^{D***}	0.079^{D***}	0.367
	(0.000)	(0.000)	(0.001)	(N/A)

	Test of Difference in Means of Benchmark Pairs				
Factor	TNR_1	$\Gamma(TNR)_2$	$DSGBI_3$	$\Gamma(DSGBI)_4$	All Factors
TNR_1					-0.336^{D***}
					(0.000)
$\Gamma(TNR)_2$	-0.003				-0.339^{D***}
	(0.789)				(0.000)
$DSGBI_3$	0.012	0.015			-0.324^{D***}
	(0.367)	(0.232)			(0.000)
$\Gamma(DSGBI)_4$	0.001^{S*}	0.004	-0.011		-0.335^{D***}
	(0.938)	(0.727)	(0.407)		(0.000)
$f_1 + f_2$	0.180^{D***}	0.183^{D***}	0.168^{D***}	0.179^{D***}	-0.156^{D***}
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
$f_3 + f_4$	0.299^{D***}	0.302^{D***}	0.287^{D***}	0.298^{D***}	-0.037
	(0.000)	(0.000)	(0.000)	(0.000)	(0.151)
$f_1 + f_3$	0.109^{D***}	0.113^{D***}	0.097^{D***}	0.108^{D***}	-0.227^{D***}
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
$f_2 + f_4$	0.024^{D*}	0.027^{D**}	0.012	0.023^{D*}	-0.313^{D***}
	(0.059)	(0.025)	(0.364)	(0.070)	(0.000)

PANEL A2: Tests of Time Series Variance (1995-1999)

Category	T-Test of Difference in Group Means 1F	2F	3F	F-Test of Group Means
1F				0.024 (0.302)
2F	0.106^{D***} (0.000)			0.129^{D***} (0.000)
3F	0.217^{D***} (0.000)	0.111^{D***} (0.000)		0.240^{D***} (0.000)
4F	0.287^{D***} (0.000)	0.181^{D***} (0.000)	0.071^{D***} (0.000)	0.311 (N/A)

Factor	Test of Difference in Means of Benchmark Pairs TNR_1	$\Gamma(TNR)_2$	$DSGBI_3$	$\Gamma(DSGBI)_4$	All Factors
TNR_1					-0.291^{D***} (0.000)
$\Gamma(TNR)_2$	0.004 (0.502)				-0.287^{D***} (0.000)
$DSGBI_3$	0.000^{S***} (0.991)	-0.004 (0.518)			-0.291^{D***} (0.000)
$\Gamma(DSGBI)_4$	0.010^{D*} (0.094)	0.006 (0.304)	0.010 (0.103)		-0.281^{D***} (0.000)
$f_1 + f_2$	0.143^{D***} (0.000)	0.139^{D***} (0.000)	0.143^{D***} (0.000)	0.133^{D***} (0.000)	-0.147^{D***} (0.000)
$f_3 + f_4$	0.287^{D***} (0.000)	0.283^{D***} (0.000)	0.287^{D***} (0.000)	0.277^{D***} (0.000)	-0.004 (0.814)
$f_1 + f_3$	0.044^{D***} (0.000)	0.040^{D***} (0.000)	0.044^{D***} (0.000)	0.034^{D***} (0.000)	-0.247^{D***} (0.000)
$f_2 + f_4$	0.058^{D***} (0.000)	0.053^{D***} (0.000)	0.057^{D***} (0.000)	0.047^{D***} (0.000)	-0.283^{D***} (0.000)

PANEL B1: Tests of Cross-Sectional Variance (1990-1994)

Category	T-Test of Difference in Group Means			F-Test of Group Means
	1F	2F	3F	
1F				0.079^{S***}
				(0.999)
2F	0.069^{D***}			0.148^{D***}
	(0.000)			(0.000)
3F	0.140^{D***}	0.071^{D***}		0.219^{D*}
	(0.000)	(0.007)		(0.051)
4F	0.190^{D***}	0.121^{D***}	0.050	0.269
	(0.000)	(0.000)	(0.160)	(N/A)

Factor	Test of Difference in Means of Benchmark Pairs				All Factors
	TNR_1	$\Gamma(TNR)_2$	$DSGBI_3$	$\Gamma(DSGBI)_4$	
TNR_1					-0.191^{D***}
					(0.000)
$\Gamma(TNR)_2$	0.001				-0.189^{D***}
	(0.894)				(0.000)
$DSGBI_3$	0.001^{S*}	0.000^{S**}			-0.190^{D***}
	(0.924)	(0.967)			(0.000)
$\Gamma(DSGBI)_4$	0.001	0.000^{S***}	0.000^{S**}		-0.189^{D***}
	(0.900)	(0.991)	(0.975)		(0.000)
$f_1 + f_2$	0.071^{D***}	0.069^{D***}	0.070^{D***}	0.069^{D***}	-0.120^{D***}
	(0.001)	(0.001)	(0.001)	(0.001)	(0.000)
$f_3 + f_4$	0.056^{D***}	0.055^{D***}	0.055^{D***}	0.055^{D***}	-0.044
	(0.002)	(0.002)	(0.002)	(0.002)	(0.247)
$f_1 + f_3$	0.056^{D***}	0.055^{D***}	0.055^{D***}	0.055^{D***}	-0.135^{D***}
	(0.002)	(0.002)	(0.002)	(0.002)	(0.000)
$f_2 + f_4$	0.055^{D***}	0.054^{D***}	0.054^{D***}	0.054^{D***}	-0.165^{D***}
	(0.002)	(0.003)	(0.002)	(0.002)	(0.000)

Combination	Analysis of Estimated Returns Contribution			
	TNR_1	$\Gamma(TNR)_2$	$DSGBI_3$	$\Gamma(DSGBI)_4$
All Factors	8.9%	7.7%	43.1%	40.3%
$f_1 + f_2$	50.8%	49.2%		
$f_3 + f_4$			50.8%	49.2%

PANEL B2: Tests of Cross-Sectional Variance (1995-1999)

Category	T-Test of Difference in Group Means 1F	2F	3F	F-Test of Group Means
1F				0.084
				(0.632)
2F	0.072^{D***}			0.156^{D***}
	(0.000)			(0.000)
3F	0.135^{D***}	0.063^{D**}		0.219^{D*}
	(0.000)	(0.017)		(0.079)
4F	0.179^{D***}	0.107^{D***}	0.044	0.263
	(0.000)	(0.001)	(0.220)	(N/A)

Factor	Test of Difference in Means of Benchmark Pairs TNR_1	$\Gamma(TNR)_2$	$DSGBI_3$	$\Gamma(DSGBI)_4$	All Factors
TNR_1					-0.181^{D***}
					(0.000)
$\Gamma(TNR)_2$	0.004				-0.176^{D***}
	(0.649)				(0.000)
$DSGBI_3$	-0.004	-0.008			-0.185^{D***}
	(0.636)	(0.354)			(0.000)
$\Gamma(DSGBI)_4$	0.007	0.003	0.011		-0.173^{D***}
	(0.445)	(0.762)	(0.215)		(0.000)
$f_1 + f_2$	0.078^{D***}	0.073^{D***}	0.082^{D***}	0.070^{D***}	-0.103^{D***}
	(0.001)	(0.003)	(0.001)	(0.004)	(0.005)
$f_3 + f_4$	0.055^{D***}	0.050^{D***}	0.059^{D***}	0.047^{D***}	-0.031
	(0.002)	(0.005)	(0.001)	(0.008)	(0.421)
$f_1 + f_3$	0.055^{D***}	0.050^{D***}	0.059^{D***}	0.047^{D***}	-0.126^{D***}
	(0.002)	(0.005)	(0.001)	(0.008)	(0.000)
$f_2 + f_4$	0.043^{D***}	0.038^{D**}	0.047^{D***}	0.035^{D**}	-0.159^{D***}
	(0.006)	(0.015)	(0.003)	(0.025)	(0.000)

Combination	Analysis of Estimated Returns Contribution TNR_1	$\Gamma(TNR)_2$	$DSGBI_3$	$\Gamma(DSGBI)_4$
All Factors	13.7%	10.5%	39.7%	36.1%
$f_1 + f_2$	49.8%	50.2%		
$f_3 + f_4$			50.5%	49.5%

F-Test of average R^2 values derived from time series regression, presented in Panels A1 and A2, show a relative substitutability of single factors, but significant differences in performance when factors are grouped into pairs or triplets. The mean explanatory power of a single factor ranges from 2.4% in 1995-99 to 3.5% in 1990-94, a far cry from the peak of 31.1% and 36.7% in the same two periods when all factors are combined. Adding extra factors into the benchmark formulation also provides a significant benefit at every level. Clearer insight is obtained when factors and factor combinations are reviewed individually. The R^2 of single factors are low varying from 2.8% to 4.3% in 1990-95 and from 2.0% to 3.0% in 1995-99. It is therefore not surprising that all of the single factors are statistically different from the peak, although it is worthy to note that the medium-term factors performed relatively better. Turning to pairs of factors, however, provides very different results. First, pairing an interest rate variable with its lagged counterpart dramatically increases the explanatory power of the benchmark. This is consistent across both periods, and for both the short term and the medium term interest rate proxies. Moreover, the good performance of medium term factors hinted at in the individual tests comes jointly to light in R^2 values of 33.0% and 30.7% for the 1990-94 and 1995-99 periods, respectively. Both figures are insignificantly different from the peak with gaps of 3.7% (p-value 0.151) and 0.4% (p-value 0.814) in the same two periods. This clearly positions a pair of these two factors as favourite to represent the Interest Rates category.

Focusing next on the results from cross-sectional regressions, a similar pattern emerges. Whilst single factors as well as triples come to be relatively good substitutes for each other, pairs of factors differ greatly as shown by F-Test statistics approximating zero in both periods. It is also clear from the first section of Panels B1 and B2 that the addition of factors beyond two, and certainly beyond three, makes relatively little difference to the explanatory power. The cross-sectional R^2 rises steadily to peak quite uniformly at 26.9% for the earlier period and 26.3% for the later. Individually, no factor comes close to this peak with drop offs ranging from 17.6% to 19.1% in the two periods, all significant at a 1% level. Early hints for the preference of the medium term factor, particularly the lagged version thereof, again emerge and are confirmed in the test of pairs. Combining an interest rate factor with its lagged counterpart again provides a dramatic improvement in the information content results. In contrast to all other pairs that still show a significant difference from the peak R^2, a pair of medium term factor and its corresponding lagged adaptation again fail to reject the null hypothesis of equality to the peak.

Reviewing the relative contributions of various factors cements the pre-selection of the DataStream Government Bond Index and the lagged version thereof as the best choice from this category. They are clearly seen to dominate the group of all factors accounting jointly for 83.4% (75.8%) of the explanatory power in 1990-94 (1995-99). As indicated in the All Factor test, the relative contribution between the spot and lagged factors is very even, a result consistent not only across the two periods but also across the two interest rate horizons. This indicates that both, the initial reaction as well as the reactions to subsequent influences of interest rate movements are important in helping explain the returns of fixed interest managed funds.

4.4 Factors Representing Economic Fundamentals

Summarised in Table 3 are the results of information content tests carried out on the group of factors representing the economic fundamentals. Included in this test are the inflation and orthogonalised GDP growth variables as well as their correspondent estimation errors (E^{ε}).

Time series analysis of the explanatory power immediately highlights large differences that exist between individual economic variables as well as their combinations. Addition of factors beyond two to three contributes little to the total R^2 of the group, which peaks at relatively modest 4.7% and 5.8% for the earlier and later period, respectively, when all factors are combined. F-Test statistics for individual factors as well as for factor pairs are highly significant, reflecting on the high degree of variance in the individual R^2 values of benchmarks in these groups. As predicted by the differential matrix of average R^2 levels, triplets of factors prove to be less varied. Examination of the individual economic variables highlights inflation as the dominating factor in explaining returns variations. Whilst comparison of this factor with the peak R^2 cannot reject the null of no difference in the 1995-99 sample, such hypothesis cannot be rejected in the earlier period. As a consequence we turn to the analysis of factor pairs for additional insights. It becomes immediately obvious that the pair of inflation and GDP growth variables dominate, performing best in absolute terms with R^2 values ranging from 3.3% to 4.6% in the earlier and later periods, respectively. What is also glaringly obvious is the weak explanatory power of the prediction error formulations of these variables, indicated by their significant difference from the peak, the only pair to do so.

Reviewing the economic variables in the context of cross-sectional information content we note a substantially lower degree of variance in the R^2 at all levels, highlighted by the F-Test statistics that are insignificant across the board and in both periods. Peak explanatory power is consistent in time reaching 12.4% and 14.8% in the 1990-94 and 1995-99 periods, respectively. Analysis of individual factors now points to a strong lead by the GDP growth variable with R^2 values of 7.6% and 9.5% in the same two periods, both of which are, however, significantly different from the peak at conventional levels. Turning therefore to pairs analysis, teaming of the GDP variable with the inflation leads to a substantial improvement with an R^2 of 9.9% for the earlier period and 11.9% for the later. Moreover, the null hypothesis of zero difference relative to peak R^2 cannot be rejected in both periods, the only pair to achieve such result.

Table 3: Two-Pass Analysis of Factors Representing Economic Fundamentals

Results in this table reflect the explanatory power inherent in factors representing economic fundamentals. The derivation of the R^2 values follows the methodology detailed previously. Panels A1 and A2 represent time based information content for the 1990-94 and 1995-99 samples, respectively. Panels B1 and B2 convey the results from cross-sectional tests for the same two periods. First section of each panel looks at the average explanatory power given a number of constituting factors, thus reflecting the average incremental information contributed by addition of more factors. Statistics attached to the group means in the last column are the results of F-Tests of joint equality of means at each factor quantity level. Section two focuses on individual variables or combinations thereof and provides not only comparative results, but also evaluation against the peak R^2 achieved when all factors are joint in a single benchmark. Third section in cross sectional test shows individual contributions of factors when combined into a multi-factor benchmark.

PANEL A1: Tests of Time Series Variance (1990-1994)

	T-Test of Difference in Group Means			F-Test of
Category	1F	2F	3F	Group Means
1F				0.010^{D**}
				(0.001)
2F	0.012^{D*}			0.022^{D**}
	(0.093)			(0.036)
3F	0.022^{D**}	0.011		0.032
	(0.015)	(0.305)		(0.400)
4F	0.037^{D***}	0.025^{D**}	0.014	0.047
	(0.000)	(0.029)	(0.273)	(N/A)

	Test of Difference in Means of Benchmark Pairs				
Factor	$INFL_1$	GDP_2	$E^{\varepsilon}(INFL)_3$	$E^{\varepsilon}(GDP)_4$	All Factors
$INFL_1$					-0.024^{D**}
					(0.040)
GDP_2	-0.018^{D**}				-0.042^{D***}
	(0.015)				(0.000)
$E^{\varepsilon}(INFL)_3$	-0.023^{D***}	-0.005			-0.047^{D***}
	(0.002)	(0.118)			(0.000)
$E^{\varepsilon}(GDP)_4$	-0.009	0.009^{D*}	0.014^{D***}		-0.033^{D***}
	(0.284)	(0.059)	(0.006)		(0.002)
$f_1 + f_2$	0.000^{S**}	0.018^{D**}	0.022^{D***}	0.009	-0.014
	(0.989)	(0.020)	(0.004)	(0.305)	(0.234)
$f_3 + f_4$	0.006	0.024^{D**}	0.029^{D***}	0.015	-0.032^{D***}
	(0.586)	(0.013)	(0.003)	(0.143)	(0.003)
$f_1 + f_3$	0.006	0.024^{D**}	0.029^{D***}	0.015	-0.018
	(0.586)	(0.013)	(0.003)	(0.143)	(0.179)
$f_2 + f_4$	0.005	0.023^{D***}	0.028^{D***}	0.014	-0.019
	(0.610)	(0.005)	(0.001)	(0.116)	(0.126)

PANEL A2: Tests of Time Series Variance (1995-1999)

	T-Test of Difference in Group Means			F-Test of
Category	1F	2F	3F	Group Means
1F				0.019^{D***}
				(0.000)
2F	0.004			0.023^{D***}
	(0.234)			(0.000)
3F	0.011^{D**}	0.007		0.030^{D*}
	(0.014)	(0.139)		(0.082)
4F	0.039^{D***}	0.035^{D***}	0.028	0.058
	(0.001)	(0.007)	(0.183)	(N/A)

	Test of Difference in Means of Benchmark Pairs				
Factor	$INFL_1$	GDP_2	$E^{\varepsilon}(INFL)_3$	$E^{\varepsilon}(GDP)_4$	All Factors
$INFL_1$					-0.024^{D*}
					(0.068)
GDP_2	-0.008				-0.031^{D***}
	(0.311)				(0.006)
$E^{\varepsilon}(INFL)_3$	-0.029^{D***}	-0.022^{D***}			-0.053^{D***}
	(0.000)	(0.000)			(0.000)
$E^{\varepsilon}(GDP)_4$	-0.025^{D***}	-0.017^{D***}	0.004		-0.049^{D***}
	(0.001)	(0.000)	(0.205)		(0.000)
$f_1 + f_2$	0.012	0.019^{D**}	0.041^{D***}	0.037^{D***}	-0.012
	(0.178)	(0.025)	(0.000)	(0.000)	(0.322)
$f_3 + f_4$	-0.010^{D*}	-0.003	0.019^{D***}	0.015^{D***}	-0.034^{D***}
	(0.053)	(0.384)	(0.000)	(0.000)	(0.000)
$f_1 + f_3$	0.002^{S**}	0.009	0.031^{D***}	0.027^{D**}	-0.022
	(0.901)	(0.384)	(0.003)	(0.011)	(0.135)
$f_2 + f_4$	0.008	0.015^{D**}	0.037^{D***}	0.032^{D***}	-0.016
	(0.374)	(0.029)	(0.000)	(0.000)	(0.185)

PANEL B1: Tests of Cross-Sectional Variance (1990-1994)

Category	T-Test of Difference in Group Means 1F	2F	3F	F-Test of Group Means
1F				0.076 (0.779)
2F	0.013 (0.150)			0.088 (0.531)
3F	0.027^{D***} (0.010)	0.014 (0.198)		0.102 (0.278)
4F	0.048^{D***} (0.000)	0.036^{D***} (0.003)	0.021^{D*} (0.098)	0.124 (N/A)

Factor	Test of Difference in Means of Benchmark Pairs $INFL_1$	GDP_2	$E^{\varepsilon}(INFL)_3$	$E^{\varepsilon}(GDP)_4$	All Factors
$INFL_1$					-0.048^{D***} (0.000)
GDP_2	0.000^{S***} (0.999)				-0.048^{D***} (0.000)
$E^{\varepsilon}(INFL)_3$	-0.004 (0.590)	-0.004 (0.583)			-0.052^{D***} (0.000)
$E^{\varepsilon}(GDP)_4$	0.004 (0.616)	0.004 (0.613)	0.009 (0.310)		-0.044^{D***} (0.000)
$f_1 + f_2$	0.018^{D*} (0.059)	0.018^{D*} (0.057)	0.022^{D**} (0.016)	0.013 (0.182)	-0.025^{D*} (0.065)
$f_3 + f_4$	0.006 (0.471)	0.006 (0.467)	0.011 (0.213)	0.002 (0.842)	-0.035^{D***} (0.005)
$f_1 + f_3$	0.006 (0.471)	0.006 (0.467)	0.011 (0.213)	0.002 (0.842)	-0.042^{D***} (0.001)
$f_2 + f_4$	0.010 (0.244)	0.010 (0.239)	0.014^{D*} (0.087)	0.006 (0.540)	-0.038^{D***} (0.002)

Combination	Analysis of Estimated Returns Contribution $INFL_1$	GDP_2	$E^{\varepsilon}(INFL)_3$	$E^{\varepsilon}(GDP)_4$
All Factors	44.9%	46.4%	6.9%	1.8%
$f_1 + f_2$	50.9%	49.1%		
$f_1 + f_3$	94.7%		5.3%	
$f_2 + f_4$		97.0%		3.0%

PANEL B2: Tests of Cross-Sectional Variance (1995-1999)

Category	T-Test of Difference in Group Means 1F	2F	3F	F-Test of Group Means
1F				0.085
				(0.370)
2F	0.020^{D*}			0.105
	(0.078)			(0.317)
3F	0.041^{D***}	0.021		0.126
	(0.002)	(0.145)		(0.280)
4F	0.063^{D***}	0.043^{D***}	0.022	0.148
	(0.000)	(0.008)	(0.203)	(N/A)

Test of Difference in Means of Benchmark Pairs

Factor	$INFL_1$	GDP_2	$E^{\varepsilon}(INFL)_3$	$E^{\varepsilon}(GDP)_4$	All Factors
$INFL_1$					-0.065^{D***}
					(0.000)
GDP_2	0.012				-0.053^{D***}
	(0.282)				(0.002)
$E^{\varepsilon}(INFL)_3$	-0.007	-0.019^{D*}			-0.072^{D***}
	(0.469)	(0.087)			(0.000)
$E^{\varepsilon}(GDP)_4$	0.002	-0.010	0.009		-0.063^{D***}
	(0.850)	(0.403)	(0.396)		(0.000)
$f_1 + f_2$	0.018	0.006	0.025^{D**}	0.016	-0.029
	(0.145)	(0.683)	(0.040)	(0.225)	(0.117)
$f_3 + f_4$	0.008	-0.004	0.015	0.006	-0.052^{D***}
	(0.424)	(0.734)	(0.133)	(0.580)	(0.002)
$f_1 + f_3$	0.008	-0.004	0.015	0.006	-0.057^{D***}
	(0.424)	(0.734)	(0.133)	(0.580)	(0.000)
$f_2 + f_4$	0.032^{D**}	0.020	0.039^{D***}	0.030^{D**}	-0.033^{D*}
	(0.012)	(0.158)	(0.002)	(0.026)	(0.052)

Analysis of Estimated Returns Contribution

Combination	$INFL_1$	GDP_2	$E^{\varepsilon}(INFL)_3$	$E^{\varepsilon}(GDP)_4$
All Factors	41.9%	51.3%	0.3%	6.5%
$f_1 + f_2$	42.6%	57.4%		
$f_1 + f_3$	97.2%		2.8%	
$f_2 + f_4$		89.3%		10.7%

The relative capability of the factors is finally revisited in the separation of contributions each factor has to the overall benchmark. Looking jointly at all economic factors clearly highlights the inflation variable and the orthogonalised GDP variable as the preferred pair, contributing between 91.3% and 93.2% to the overall explanatory power. In the 1990-94 sample such a contribution is in approximately equal weights, whilst in for the 1995-99 sample a marginal tilt in favour of the FDP factor can be observed. As a test of robustness we have also reviewed performance of the inflation and GDP variables relative to their expectation error counterparts ($f_1 + f_3$ and $f_2 + f_4$). In both cases the standard variable definition significantly dominates.

As a result of the above information tests we select the inflation and the GDP variables as the appropriate factors reflecting economic influences on the returns of fixed interest managed funds. This choice differs from that of Elton, Gruber and Blake (1995) who have selected the estimation error variables by default in their test, without express consideration for any potential benefit standard definitions of these variables may contribute.

4.5 Factors Representing Term or Maturity Risk

Table 4 shows the summary of results for the tests of explanatory power offered by proxies for the term premium related to the maturity risk. First variable, δ(GBR,TNR) reflects the spread between long term 10-Year Government Bond Rates (GBR) and the short term 90-Day Treasury Note Rates (TNR). Second variable, $\delta(DS_L,DS_{1\text{-}3Y})$ looks at the premium between the long horizon DataStream index of government bonds with ten or more years to maturity (DS_L) and the DataStream index of government bonds with a medium term horizon of one to three years ($DS_{1\text{-}3Y}$).

F-Test statistics from the temporal part of this analysis show the two factors to differ significantly from each other in terms of their information content, being significant at a 1% level in both periods. Whilst they collectively add up to a peak of 14.2% for 1990-94 and 13.8% for 1995-99, there is a significant increase from first to the second level. As the comparison of individual factors reveals, however, this is due to the significantly lower explanatory power for the long-short premium variable that pulls down the average of single-factor R^2. This factor achieves a mere 2.5% R^2 in both periods compared to the medium-to-long term premium variable that records R^2 values of 11.7% in the earlier period and 10.6% in the later. These figures are also not different from the peak at conventional statistical levels.

Table 4: Two-Pass Analysis of Factors Representing Term or Maturity Risk

Results in this table reflect the explanatory power inherent in factors representing term (or maturity) risk. The derivation of the R^2 values follows the methodology detailed previously. Panels A1 and A2 represent time based information content for the 1990-94 and 1995-99 samples, respectively. Panels B1 and B2 convey the results from cross-sectional tests for the same two periods. First section of each panel looks at the average explanatory power given a number of constituting factors, thus reflecting the average incremental information contributed by addition of more factors. Statistics attached to the group means in the last column are the results of F-Tests of joint equality of means at each factor quantity level. Section two focuses on individual variables or combinations thereof and provides not only comparative results, but also evaluation against the peak R^2 achieved when all factors are joint in a single benchmark. Third section in cross sectional test shows individual contributions of factors when combined into a multi-factor benchmark.

PANEL A: Tests of Time-Series Variance

(1990-1994)

Differential T-Test and F-Test of Group Means

	1F	μ (F)
1F		0.071^{D***}
		(0.002)
2F	0.071^{D***}	0.142
	(0.001)	(N/A)

T-Test of Difference in Benchmark Pairs

	$\delta(GBR,TNR)_1$	$\delta(DS_L,DS_{1\text{-}3Y})_2$
$\delta(DS_L,DS_{1\text{-}3Y})_2$	0.092^{D***}	
	(0.002)	
$f_1 + f_2$	0.117^{D***}	0.025
	(0.000)	(0.415)

(1995-1999)

Differential T-Test and F-Test of Group Means

	1F	μ (F)
1F		0.065^{D***}
		(0.000)
2F	0.073^{D***}	0.138
	(0.000)	(N/A)

T-Test of Difference in Benchmark Pairs

	$\delta(GBR,TNR)_1$	$\delta(DS_L,DS_{1\text{-}3Y})_2$
$\delta(DS_L,DS_{1\text{-}3Y})_2$	0.081^{D***}	
	(0.006)	
$f_1 + f_2$	0.114^{D***}	0.032
	(0.000)	(0.211)

PANEL B: Tests of Cross Sectional Variance

(1990-1994)

Differential T-Test and F-Test of Group Means

	1F	μ (F)
1F		0.099^{D**}
		(0.014)
2F	0.031	0.131
	(0.101)	(N/A)

T-Test of Difference in Benchmark Pairs

	$\delta(GBR,TNR)_1$	$\delta(DS_L,DS_{1\text{-}3Y})_2$
$\delta(DS_L,DS_{1\text{-}3Y})_2$	0.037^{D**}	
	(0.014)	
$f_1 + f_2$	0.050^{D***}	0.013
	(0.008)	(0.510)

Analysis of Estimated Returns Contribution

	$\delta(GBR,TNR)_1$	$\delta(DS_L,DS_{1\text{-}3Y})_2$
All Factors	28.7%	71.3%

(1995-1999)

Differential T-Test and F-Test of Group Means

	1F	μ (F)
1F		0.077
		(0.267)
2F	0.027^{D**}	0.104
	(0.022)	(N/A)

T-Test of Difference in Benchmark Pairs

	$\delta(GBR,TNR)_1$	$\delta(DS_L,DS_{1\text{-}3Y})_2$
$\delta(DS_L,DS_{1\text{-}3Y})_2$	0.010	
	(0.268)	
$f_1 + f_2$	0.032^{D***}	0.022^{D*}
	(0.006)	(0.076)

Analysis of Estimated Returns Contribution

	$\delta(GBR,TNR)_1$	$\delta(DS_L,DS_{1\text{-}3Y})_2$
All Factors	33.9%	66.1%

Reviewing the cross-sectional performance shows slightly higher similarity between the two benchmarks with an insignificant F-Test statistic in the later period, although the term premium proxy focusing on the medium to long term is again shown to perform better than the factor proxying for the differential between short term and long term horizon. The composite Datastream Government Bond Index reflecting the premium between instruments with term of more than ten years and instruments with maturity of one to three years provides an R^2 of 11.8% in 1990-94 and 8.2% in 1995-99. A hypothesis of zero difference from the peak R^2 values, which stand at 13.1% and 10.4% in the respective periods, cannot be rejected at conventional statistical levels. Separation of factor contributions also confirms the dominance of this variable when it is show to account for between 66.1% and 71.3% of the group R^2.

The above preference for a factor reflecting the maturity premium between medium and long-term rates is consistent with Elton, Gruber and Blake (1995) who also used the differential rate between intermediate and long-term bonds. It also concurs with the variations of this variable used by Brennan and Schwartz (1983).

4.6 Factors Representing Default Risk

The information efficiency analysis of factors representing default risk is presented in Table 5. Factors on both sides of the risk spectrum are considered. Whilst the Lehman Brothers High Yield Index (LB HYI) reflects the influence holding of non-investment grade bonds has on returns of fixed interest managed funds, the Warburg Dillon Read Asset Backed Securities index (WDR ABS) introduces the information impact of a low risk – low return investment strategy.

Although the peak time series R^2 for this category stands consistently at 16.2% across the two periods, F-Test indications on the substitutability of factors conclusively point to significant differences in the explanatory power of the two variables. This is indeed confirmed by the review of individual factors, where the High Yield Index proves to be the dominating factor achieving R^2 values of 15.5% and 15.6% in the earlier and the later time frames, both insignificantly different from the peak. This contrasts dramatically with the explanatory power of the Asset Backed Index, which achieves a mere 2.0% and 5.9% in the two periods.

Table 5: Two-Pass Analysis of Factors Representing Default Risk

Results in this table reflect the explanatory power inherent in factors representing term (or maturity) risk. The derivation of the R^2 values follows the methodology detailed previously. Panels A1 and A2 represent time based information content for the 1990-94 and 1995-99 samples, respectively. Panels B1 and B2 convey the results from cross-sectional tests for the same two periods. First section of each panel looks at the average explanatory power given a number of constituting factors, thus reflecting the average incremental information contributed by addition of more factors. Statistics attached to the group means in the last column are the results of F-Tests of joint equality of means at each factor quantity level. Section two focuses on individual variables or combinations thereof and provides not only comparative results, but also evaluation against the peak R^2 achieved when all factors are joint in a single benchmark. Third section in cross sectional test shows individual contributions of factors when combined into a multi-factor benchmark.

PANEL A: Tests of Time-Series Variance

(1990-1994)

Differential T-Test and F-Test of Group Means

	1F	μ (F)
1F		0.087^{D***}
		(0.000)
2F	0.074^{D***}	0.162
	(0.000)	(N/A)

T-Test of Difference in Benchmark Pairs

	WDR ABS_1	LB HYI_2
LB HYI_2	0.135^{D***}	
	(0.000)	
$f_1 + f_2$	0.142^{D***}	0.007
	(0.000)	(0.686)

(1995-1999)

Differential T-Test and F-Test of Group Means

	1F	μ (F)
1F		0.107^{D***}
		(0.000)
2F	0.055^{D***}	0.162
	(0.000)	(N/A)

T-Test of Difference in Benchmark Pairs

	WDR ABS_1	LB HYI_2
LB HYI_2	0.095^{D***}	
	(0.000)	
$f_1 + f_2$	0.103^{D***}	0.008
	(0.000)	(0.634)

PANEL B: Tests of Cross Sectional Variance

(1990-1994)

Differential T-Test and F-Test of Group Means

	1F	μ (F)
1F		0.133^{D***}
		(0.001)
2F	0.058^{D***}	0.191
	(0.009)	(N/A)

T-Test of Difference in Benchmark Pairs

	WDR ABS_1	LB HYI_2
LB HYI_2	0.066^{D***}	
	(0.001)	
$f_1 + f_2$	0.091^{D***}	0.025
	(0.000)	(0.301)

Analysis of Estimated Returns Contribution

	WDR ABS_1	LB HYI_2
All Factors	0.1%	99.9%

(1995-1999)

Differential T-Test and F-Test of Group Means

	1F	μ (F)
1F		0.168^{D**}
		(0.028)
2F	0.065^{D**}	0.233
	(0.021)	(N/A)

T-Test of Difference in Benchmark Pairs

	WDR ABS_1	LB HYI_2
LB HYI_2	0.057^{D**}	
	(0.049)	
$f_1 + f_2$	0.093^{D***}	0.036
	(0.001)	(0.229)

Analysis of Estimated Returns Contribution

	WDR ABS_1	LB HYI_2
All Factors	4.8%	95.2%

Turning attention to the 1990-94 cross-sectional results confirms the better performance of the High Yield Index which explains 16.6% of the spectral returns variations of fixed interest managed funds, a figure not significantly different from the peak of 19.1%. Similar results are recorded in the 1995-99 period with the index achieving an R^2 of 19.7% against a 23.3% peak, a gap that is again not significant at conventional levels.

Perhaps the most telling result of the dominance High Yield Index has to the exclusion of the Asset Backed Index are the contributions of the individual factors in a joint test, with the former index providing as much as 99.9% of the aggregate R^2.

The above results lead to a firm conclusion that it is indeed that influence of returns from non-investment grade bonds that are best able to explain the fixed interest fund variations in this category of factors. This also suggests an early concurrence with the conclusion formed by Blake, Elton and Gruber (1993:383) that an investor studying performance of managed bond funds "would reach similar conclusions no matter which measure was used, as long as the measure contained a high-yield index".

4.7 Factors Representing Equity Market Returns

Table 6 previews the influence factors based on the equity markets bear on variations in returns of fixed interest managed funds. Maag and Zimmerman (2000) previously examined the exposure to equity markets bond funds can take through instruments such as convertibles and warrants. The strength of their impact will be tested herein through two factors, distinguished by the variety of equities whose returns they track. Whilst the All Ordinaries Index (AOI) focuses specifically at the largest stocks listed on the Australian stock exchange, the 500 Value Weighted Index (500VW) takes a broader view by including a wider spectrum of equities.

In both periods and in both information dimensions the two factor candidates prove to be significantly different recording F-Test statistics that approximate zero. Examining first the R^2 values from time-series regressions I find that the difference arises due to significantly better performance by the All Ordinaries Index. The index explains up to 14.3% of return variations in 1990-94 relative to the peak of 14.6%, and 20.6% in 1995-99 relative to the peak of 21.6%. Neither difference is statistically significant at conventional levels. The preference for AOI index in lieu of the 500 Value Weighted index is also reconfirmed in cross-sectional tests, although the difference is now less dramatic. AOI index records an R^2 of 19.9% and 22.4% in the earlier and later time frame, respectively, falling short of the peak by statistically

Table 6: Two-Pass Analysis of Factors Representing Equity Market Movement

Results in this table reflect the explanatory power inherent in factors representing equity market movements. The derivation of the R^2 values follows the methodology detailed previously. Panels A1 and A2 represent time based information content for the 1990-94 and 1995-99 samples, respectively. Panels B1 and B2 convey the results from cross-sectional tests for the same two periods. First section of each panel looks at the average explanatory power given a number of constituting factors, thus reflecting the average incremental information contributed by addition of more factors. Statistics attached to the group means in the last column are the results of F-Tests of joint equality of means at each factor quantity level. Section two focuses on individual variables or combinations thereof and provides not only comparative results, but also evaluation against the peak R^2 achieved when all factors are joint in a single benchmark. Third section in cross sectional test shows individual contributions of factors when combined into a multi-factor benchmark.

PANEL A: Tests of Time-Series Variance

(1990-1994)

Differential T-Test and F-Test of Group Means

	1F	μ (F)
1F		0.119^{D***}
		(0.001)
2F	0.027^{D*}	0.146
	(0.094)	(N/A)

T-Test of Difference in Benchmark Pairs

	AOI_1	$500VW_2$
$500VW_2$	-0.048^{D***}	
	(0.001)	
$f_1 + f_2$	0.003	0.051^{D***}
	(0.873)	(0.001)

(1995-1999)

Differential T-Test and F-Test of Group Means

	1F	μ (F)
1F		0.120^{D***}
		(0.000)
2F	0.095^{D***}	0.216
	(0.000)	(N/A)

T-Test of Difference in Benchmark Pairs

	AOI_1	$500VW_2$
$500VW_2$	-0.170^{D***}	
	(0.000)	
$f_1 + f_2$	0.010	0.180^{D***}
	(0.511)	(0.000)

PANEL B: Tests of Cross Sectional Variance

(1990-1994)

Differential T-Test and F-Test of Group Means

	1F	μ (F)
1F		0.175^{D*}
		(0.091)
2F	0.040	0.215
	(0.127)	(N/A)

T-Test of Difference in Benchmark Pairs

	AOI_1	$500VW_2$
$500VW_2$	-0.045^{D*}	
	(0.091)	
$f_1 + f_2$	0.016	0.062^{D**}
	(0.550)	(0.023)

Analysis of Estimated Returns Contribution

	AOI_1	$500VW_2$
All Factors	72.8%	27.2%

(1995-1999)

Differential T-Test and F-Test of Group Means

	1F	μ (F)
1F		0.160^{D***}
		(0.000)
2F	0.088^{D***}	0.248
	(0.002)	(N/A)

T-Test of Difference in Benchmark Pairs

	AOI_1	$500VW_2$
$500VW_2$	-0.128^{D***}	
	(0.000)	
$f_1 + f_2$	0.024	0.152^{D***}
	(0.470)	(0.000)

Analysis of Estimated Returns Contribution

	AOI_1	$500VW_2$
All Factors	68.5%	31.5%

insignificant 1.6% and 2.4% in the same periods. Finding the All Ordinaries Index to contribute between 68.5% and 72.8% of the joint explanatory power for the two indices confirms that the exposure fixed interest funds acquire is mostly to the large, generally blue chip equities. This also concurs with the testing methodology adopted by Maag and Zimmerman (2000).

4.8 Explanatory Power of Winning Factors Across All Categories

Table 7 presents a summary of results derived from the information efficiency tests carried for the pre-selected winners from each factor category. In summary these include the equally weighted fund-based index (EW), economic proxies for inflation (INFL) and the orthogonalised measure of GDP growth (GDP), index for high yield non-investment grade bond securities (LBHYI), the All Ordinaries Index (AOI), DataStream medium term interest rate factor (DSGBI) and the lagged variant thereof (ΓDS_{GBI}) and finally the term premium between the long term and medium term fixed interest securities (δDS_{LM}). The objective of this joint analysis is to search whether the peak R^2 of this group can be achieved in a more parsimonious manner with a lower number of factors.

Table 7: Two-Pass Analysis of Winning Factors Representing Potential Sources of Return Variations

Results in this table represent the explanatory power provided by the factors found previously to be most informative in tests of various categories. The derivation of the R^2 values follows the methodology detailed previously. Panels A1 and A2 represent time based information content for the 1990-94 and 1995-99 samples, respectively. Panels B1 and B2 convey the results from cross-sectional tests for the same two periods. First section of each panel looks at the average explanatory power given a number of constituting factors, thus reflecting the average incremental information contributed by addition of more factors. Statistics attached to the group means in the last column are the results of F-Tests of joint equality of means at each factor quantity level. Section two focuses on individual variables or combinations thereof and provides not only comparative results, but also evaluation against the peak R^2 achieved when all factors are joint in a single benchmark. Third section in cross sectional test shows individual contributions of factors when combined into a multi-factor benchmark.

PANEL A1: Tests of Time-Series Variance (1990-1994)

Category†	T-Test of Difference in Group Means 1F	2F	3F	4F	5F	6F	7F	F-Test of Grp Means
1F								0.157^{D***}
								(0.000)
2F	0.207^{D***}							0.363^{D***}
	(0.000)							(0.000)
3F	0.377^{D***}	0.171^{D***}						0.534^{D***}
	(0.000)	(0.000)						(0.000)
4F	0.523^{D***}	0.316^{D***}	0.145^{D***}					0.680^{D***}
	(0.000)	(0.000)	(0.002)					(0.000)
5F	0.637^{D***}	0.430^{D***}	0.259^{D***}	0.114^{D**}				0.794^{D***}
	(0.000)	(0.000)	(0.000)	(0.044)				(0.000)
6F	0.718^{D***}	0.511^{D***}	0.341^{D***}	0.195^{D***}	0.081			0.875^{D***}
	(0.000)	(0.000)	(0.000)	(0.001)	(0.201)			(0.000)
7F	0.769^{D***}	0.562^{D***}	0.391^{D***}	0.246^{D***}	0.132^{D**}	0.051		0.926
	(0.000)	(0.000)	(0.000)	(0.000)	(0.043)	(0.455)		(0.832)
8F	0.796^{D***}	0.589^{D***}	0.418^{D***}	0.273^{D***}	0.159^{D**}	0.078	0.027	0.952
	(0.000)	(0.000)	(0.000)	(0.000)	(0.017)	(0.259)	(0.702)	(N/A)

Factor‡	T-Test of Difference in Means of Benchmark Pairs EW_1	$INFL_2$	GDP_3	$LBHYI_4$	AOI_5	$DSGBI_6$	$\Gamma DSGBI_7$	$\delta DSLM_8$	All Factors
EW_1									-0.216^{D***}
									(0.009)
$INFL_2$	-0.713^{D***}								-0.929^{D***}
	(0.000)								(0.000)
GDP_3	-0.731^{D***}	-0.018^{D**}							-0.947^{D***}
	(0.000)	(0.015)							(0.000)
$LBHYI_4$	-0.581^{D***}	0.132	0.150^{D***}						-0.797^{D***}
	(0.000)	(0.755)	(0.000)						(0.000)
AOI_5	-0.593^{D***}	0.120^{D***}	0.138^{D***}	-0.012^{D***}					-0.809^{D***}
	(0.000)	(0.000)	(0.000)	(0.000)					(0.000)
$DSGBI_6$	-0.693^{D***}	0.020^{D*}	0.038^{D***}	-0.112^{D**}	-0.100^{D***}				-0.909^{D***}
	(0.000)	(0.083)	(0.000)	(0.025)	(0.000)				(0.000)
$\Gamma DSGBI_7$	-0.704^{D***}	0.009	0.027^{D***}	-0.123	-0.111^{D***}	-0.011			-0.920^{D***}
	(0.000)	(0.376)	(0.003)	(0.190)	(0.000)	(0.407)			(0.000)
$\delta DSLM_8$	-0.619^{D***}	0.094	0.112^{D***}	-0.038^{D*}	-0.026^{D***}	0.074	0.085		-0.835^{D***}
	(0.000)	(0.159)	(0.001)	(0.060)	(0.000)	(0.757)	(0.605)		(0.000)
$f_{1,6}$	0.077	0.790^{D***}	0.808^{D***}	0.658^{D***}	0.670^{D***}	0.770^{D***}	0.781^{D***}	0.696^{D***}	-0.140^{D***}
	(0.486)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.009)
$f_{1,5,6}$	0.151^{D*}	0.864^{D***}	0.882^{D***}	0.732^{D***}	0.744^{D***}	0.844^{D***}	0.855^{D***}	0.770^{D***}	-0.066
	(0.089)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.356)
$f_{1,5,7}$	0.148^{D*}	0.861^{D***}	0.879^{D***}	0.729^{D***}	0.741^{D***}	0.841^{D***}	0.852^{D***}	0.767^{D***}	-0.069
	(0.097)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.337)
$f_{1,6,7}$	0.148^{D*}	0.861^{D***}	0.879^{D***}	0.729^{D***}	0.741^{D***}	0.841^{D***}	0.852^{D***}	0.767^{D***}	-0.068
	(0.090)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.333)
$f_{1,5,6,7}$	0.183^{D**}	0.896^{D***}	0.914^{D***}	0.764^{D***}	0.776^{D***}	0.876^{D***}	0.887^{D***}	0.802^{D***}	-0.034
	(0.032)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.734)
$f_{1,4,5,6,7}$	0.203^{D**}	0.916^{D***}	0.934^{D***}	0.784^{D***}	0.796^{D***}	0.896^{D***}	0.907^{D***}	0.822^{D***}	-0.013^{S**}
	(0.015)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.953)

† Corresponds to groups of benchmarks incorporating one through to eight factors.
‡ EW_1 refers to the Equally Weighted Indices of Managed Bond Fund Returns, $INFL_2$ is a measure of inflation, GDP_3 tracks the GDP growth of the economy, orthogonalised against the inflation variable, $LBHYI_4$ is an index of high yield non-investment grade securities tracked by Lehman Brothers reflecting the performance of risky assets, AOI_5 is the All Ordinaries Accumulation Index, $DSGBI_6$ is the DataStream index of government securities with medium term (1 to 3 years) maturities and $\Gamma(DSGBI)_7$ is a lagged variant thereof. Final variable $\delta DSLM_8$ is a proxy for term premium defined as the difference between returns on long term and medium term government bonds.

PANEL A2: Tests of Time-Series Variance (1995-1999)

Category	T-Test of Difference in Group Means							F-Test of
	1F	2F	3F	4F	5F	6F	7F	Grp Means
1F								0.173^{D***}
								(0.000)
2F	0.174^{D***}							0.347^{D***}
	(0.000)							(0.000)
3F	0.337^{D***}	0.163^{D***}						0.510^{D***}
	(0.000)	(0.000)						(0.000)
4F	0.481^{D***}	0.307^{D***}	0.143^{D***}					0.653^{D***}
	(0.000)	(0.000)	(0.000)					(0.000)
5F	0.599^{D***}	0.425^{D***}	0.261^{D***}	0.118^{D***}				0.771^{D***}
	(0.000)	(0.000)	(0.000)	(0.000)				(0.000)
6F	0.689^{D***}	0.515^{D***}	0.352^{D***}	0.209^{D***}	0.090^{D**}			0.862^{D***}
	(0.000)	(0.000)	(0.000)	(0.000)	(0.012)			(0.000)
7F	0.752^{D***}	0.578^{D***}	0.415^{D***}	0.271^{D***}	0.153^{D***}	0.063^{D*}		0.924^{D*}
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.089)		(0.050)
8F	0.787^{D***}	0.612^{D***}	0.449^{D***}	0.306^{D***}	0.188^{D***}	0.097^{D*}	0.035	0.959
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.050)	(0.363)	(N/A)

Factor	T-Test of Difference in Means of Benchmark Pairs								All
	EW_1	$INFL_2$	GDP_3	$LBHYI_4$	AOI_5	$DSGBI_6$	$\Gamma DSGBI_7$	$\delta DSLM_8$	Factors
EW_1									-0.158^{D***}
									(0.000)
$INFL_2$	-0.767^{D***}								-0.925^{D***}
	(0.000)								(0.000)
GDP_3	-0.774^{D***}	-0.007							-0.932^{D***}
	(0.000)	(0.311)							(0.000)
$LBHYI_4$	-0.647^{D***}	0.120^{D***}	0.127^{D***}						-0.805^{D***}
	(0.000)	(0.000)	(0.000)						(0.000)
AOI_5	-0.595^{D***}	0.172^{D***}	0.179^{D***}	0.052^{D***}					-0.753^{D***}
	(0.000)	(0.000)	(0.000)	(0.000)					(0.000)
$DSGBI_6$	-0.781^{D***}	-0.014^{D***}	-0.007^{D***}	-0.134^{D***}	-0.186^{D***}				-0.939^{D***}
	(0.000)	(0.006)	(0.000)	(0.000)	(0.000)				(0.000)
$\Gamma DSGBI_7$	-0.771^{D***}	-0.004^{D***}	0.003^{D***}	-0.124^{D***}	-0.176^{D***}	0.010			-0.929^{D***}
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.103)			(0.000)
$\delta DSLM_8$	-0.695^{D***}	0.072^{D***}	0.079^{D***}	-0.048^{D***}	-0.100^{D***}	0.086	0.076^{D***}		-0.853^{D***}
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.679)	(0.006)		(0.000)
$f_{1,7}$	0.072^{D***}	0.839^{D***}	0.846^{D***}	0.719^{D***}	0.667^{D***}	0.853^{D***}	0.843^{D***}	0.767^{D***}	-0.086^{D***}
	(0.005)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.004)
$f_{1,5,6}$	0.096^{D***}	0.863^{D***}	0.870^{D***}	0.743^{D***}	0.691^{D***}	0.877^{D***}	0.867^{D***}	0.791^{D***}	-0.062
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.107)
$f_{1,5,7}$	0.095^{D***}	0.862^{D***}	0.869^{D***}	0.742^{D***}	0.690^{D***}	0.876^{D***}	0.866^{D***}	0.790^{D***}	-0.064
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.100)
$f_{1,6,7}$	0.062^{D***}	0.829^{D***}	0.836^{D***}	0.709^{D***}	0.657^{D***}	0.843^{D***}	0.833^{D***}	0.757^{D***}	-0.096^{D**}
	(0.001)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.011)
$f_{1,5,6,7}$	0.139^{D***}	0.906^{D***}	0.913^{D***}	0.786^{D***}	0.734^{D***}	0.920^{D***}	0.910^{D***}	0.834^{D***}	-0.019
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.628)
$f_{1,4,5,6,7}$	0.149^{D***}	0.916^{D***}	0.923^{D***}	0.796^{D***}	0.744^{D***}	0.930^{D***}	0.920^{D***}	0.844^{D***}	-0.010^{S**}
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.950)

PANEL B1: Tests of Cross-Sectional Variance (1990-1994)

Category	T-Test of Difference in Group Means 1F	2F	3F	4F	5F	6F	7F	F-Test of Grp Means
1F								0.169^{D***}
								(0.000)
2F	0.136^{D***}							0.305^{D***}
	(0.000)							(0.000)
3F	0.342^{D***}	0.206^{D***}						0.511^{D***}
	(0.000)	(0.003)						(0.000)
4F	0.451^{D***}	0.315^{D***}	0.108^{D**}					0.620^{D***}
	(0.000)	(0.000)	(0.043)					(0.000)
5F	0.544^{D***}	0.408^{D***}	0.202^{D***}	0.093				0.713^{D***}
	(0.000)	(0.000)	(0.001)	(0.155)				(0.000)
6F	0.621^{D***}	0.485^{D***}	0.279^{D***}	0.170^{D**}	0.077			0.790
	(0.000)	(0.000)	(0.000)	(0.017)	(0.309)			(0.170)
7F	0.684^{D***}	0.548^{D***}	0.342^{D***}	0.233^{D***}	0.140^{D*}	0.063		0.853
	(0.000)	(0.000)	(0.000)	(0.002)	(0.080)	(0.452)		(0.876)
8F	0.739^{D***}	0.603^{D***}	0.397^{D***}	0.288^{D***}	0.195^{D**}	0.118	0.055	0.908
	(0.000)	(0.000)	(0.000)	(0.000)	(0.020)	(0.177)	(0.545)	(N/A)

Factor	T-Test of Difference in Means of Benchmark Pairs EW$_1$	INFL$_2$	GDP$_3$	LBHYI$_4$	AOI$_5$	DSGBI$_6$	ΓDSGBI$_7$	δDSLM$_8$	All Factors
EW$_1$									-0.352^{D***}
									(0.001)
INFL$_2$	-0.480^{D***}								-0.832^{D***}
	(0.000)								(0.000)
GDP$_3$	-0.480^{D***}	0.000^{S***}							-0.832^{D***}
	(0.000)	(0.999)							(0.000)
LBHYI$_4$	-0.390^{D***}	0.090^{D*}	0.090^{D*}						-0.742^{D***}
	(0.000)	(0.067)	(0.066)						(0.000)
AOI$_5$	-0.357^{D**}	0.123^{D***}	0.123^{D***}	0.033^{D***}					-0.709^{D***}
	(0.017)	(0.000)	(0.000)	(0.000)					(0.000)
DSGBI$_6$	-0.477^{D***}	0.003	0.003	-0.087	-0.120^{D***}				-0.829^{D***}
	(0.000)	(0.707)	(0.705)	(0.124)	(0.000)				(0.000)
ΓDSGBI$_7$	-0.476^{D***}	0.004	0.004	-0.086	-0.119^{D***}	0.001^{S**}			-0.828^{D***}
	(0.000)	(0.684)	(0.681)	(0.130)	(0.000)	(0.975)			(0.000)
δDSLM$_8$	-0.438^{D***}	0.042	0.042	-0.048	-0.081^{D***}	0.039^{S**}	0.038^{S*}		-0.790^{D***}
	(0.000)	(0.770)	(0.769)	(0.129)	(0.000)	(0.961)	(0.938)		(0.000)
$f_{1,5,6,7}$	0.255^{D**}	0.735^{D***}	0.735^{D***}	0.645^{D***}	0.612^{D***}	0.732^{D***}	0.731^{D***}	0.693^{D***}	-0.096^{D**}
	(0.026)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.012)
$f_{1,2,5,6,7}$	0.291^{D***}	0.771^{D***}	0.771^{D***}	0.681^{D***}	0.648^{D***}	0.768^{D***}	0.767^{D***}	0.729^{D***}	-0.060^{D*}
	(0.009)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.081)
$f_{1,3,5,6,7}$	0.265^{D**}	0.745^{D***}	0.745^{D***}	0.655^{D***}	0.622^{D***}	0.742^{D***}	0.741^{D***}	0.703^{D***}	-0.087^{D**}
	(0.019)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.045)
$f_{1,2,3,5,6,7}$	0.329^{D***}	0.809^{D***}	0.809^{D***}	0.719^{D***}	0.686^{D***}	0.806^{D***}	0.805^{D***}	0.767^{D***}	-0.023
	(0.003)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.408)

Analysis of Estimated Returns Contribution

Combination	EW$_1$	INFL$_2$	GDP$_3$	LBHYI$_4$	AOI$_5$	DSGBI$_6$	ΓDSGBI$_7$	δDSLM$_8$
$f_{1,5,6,7}$	76.2%				2.3%	10.9%	10.6%	
$f_{1,2,5,6,7}$	67.6%	9.6%			2.3%	10.1%	10.4%	
$f_{1,3,5,6,7}$	74.9%		1.3%		2.3%	10.8%	10.6%	
$f_{1,2,3,5,6,7}$	64.7%	10.5%	2.7%		2.5%	9.6%	10.0%	
All Factors	58.5%	13.1%	5.5%	0.0%	2.1%	10.3%	10.4%	0.2%

PANEL B2: Tests of Cross-Sectional Variance (1995-1999)

Category	T-Test of Difference in Group Means 1F	2F	3F	4F	5F	6F	7F	F-Test of Grp Means
1F								0.188^{D***}
								(0.000)
2F	0.169^{D***}							0.357^{D***}
	(0.000)							(0.000)
3F	0.286^{D***}	0.117^{D***}						0.474^{D***}
	(0.000)	(0.000)						(0.000)
4F	0.396^{D***}	0.227^{D***}	0.110^{D**}					0.584^{D***}
	(0.000)	(0.000)	(0.011)					(0.000)
5F	0.497^{D***}	0.328^{D***}	0.211^{D***}	0.101^{D*}				0.685^{D***}
	(0.000)	(0.000)	(0.000)	(0.054)				(0.000)
6F	0.588^{D***}	0.419^{D***}	0.302^{D***}	0.193^{D***}	0.091			0.776^{D***}
	(0.000)	(0.000)	(0.000)	(0.001)	(0.131)			(0.000)
7F	0.670^{D***}	0.501^{D***}	0.385^{D***}	0.275^{D***}	0.174^{D***}	0.082		0.858
	(0.000)	(0.000)	(0.000)	(0.000)	(0.007)	(0.222)		(0.482)
8F	0.745^{D***}	0.576^{D***}	0.460^{D***}	0.350^{D***}	0.249^{D***}	0.157^{D**}	0.075	0.933
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.025)	(0.300)	(N/A)

Factor	T-Test of Difference in Means of Benchmark Pairs EW_1	$INFL_2$	GDP_3	$LBHYI_4$	AOI_5	$DSGBI_6$	$\Gamma DSGBI_7$	$\delta DSLM_8$	All Factors
EW_1									-0.278^{D***}
									(0.000)
$INFL_2$	-0.572^{D***}								-0.850^{D***}
	(0.000)								(0.000)
GDP_3	-0.560^{D***}	0.012							-0.838^{D***}
	(0.000)	(0.282)							(0.000)
$LBHYI_4$	-0.458^{D***}	0.114^{D**}	0.102						-0.736^{D***}
	(0.000)	(0.023)	(0.168)						(0.000)
AOI_5	-0.431	0.141^{D***}	0.129^{D***}	0.027^{D***}					-0.709^{D***}
	(0.102)	(0.000)	(0.000)	(0.000)					(0.000)
$DSGBI_6$	-0.577^{D***}	-0.005	-0.017	-0.119^{D***}	-0.146^{D***}				-0.855^{D***}
	(0.000)	(0.617)	(0.117)	(0.008)	(0.000)				(0.000)
$\Gamma DSGBI_7$	-0.565^{D***}	0.007	-0.005	-0.107^{D*}	-0.134^{D***}	0.012			-0.843^{D***}
	(0.000)	(0.498)	(0.625)	(0.066)	(0.000)	(0.215)			(0.000)
$\delta DSLM_8$	-0.573^{D***}	-0.001^{S*}	-0.013	-0.115^{D**}	-0.142^{D***}	0.004	-0.008		-0.851^{D***}
	(0.000)	(0.904)	(0.241)	(0.019)	(0.000)	(0.718)	(0.429)		(0.000)
$f_{1,5,6,7}$	0.176^{D***}	0.748^{D***}	0.736^{D***}	0.634^{D***}	0.607^{D***}	0.753^{D***}	0.741^{D***}	0.749^{D***}	-0.102^{D**}
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.011)
$f_{1,2,5,6,7}$	0.205^{D***}	0.777^{D***}	0.765^{D***}	0.663^{D***}	0.636^{D***}	0.782^{D***}	0.770^{D***}	0.778^{D***}	-0.073^{D*}
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.069)
$f_{1,3,5,6,7}$	0.201^{D***}	0.773^{D***}	0.761^{D***}	0.659^{D***}	0.632^{D***}	0.778^{D***}	0.766^{D***}	0.774^{D***}	-0.077^{D*}
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.064)
$f_{1,2,3,5,6,7}$	0.231^{D***}	0.803^{D***}	0.791^{D***}	0.689^{D***}	0.662^{D***}	0.808^{D***}	0.796^{D***}	0.804^{D***}	-0.047
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.227)

Analysis of Estimated Returns Contribution

Combination	EW_1	$INFL_2$	GDP_3	$LBHYI_4$	AOI_5	$DSGBI_6$	$\Gamma DSGBI_7$	$\delta DSLM_8$
$f_{1,5,6,7}$	74.9%				2.9%	11.8%	10.4%	
$f_{1,2,5,6,7}$	67.4%	9.0%			2.7%	10.7%	10.1%	
$f_{1,3,5,6,7}$	71.6%		4.2%		2.6%	11.4%	10.1%	
$f_{1,2,3,5,6,7}$	64.9%	8.5%	3.7%		2.6%	10.5%	9.9%	
All Factors	59.4%	9.4%	5.9%	0.1%	3.5%	10.6%	10.4%	0.7%

Temporal analysis of R^2 averages reveals that while addition of extra factors contributed significantly to the information content carried by the benchmark, such increments in explanatory power do experience diminishing returns. In fact, combining more than six factors to form a benchmark has no real benefit at conventional statistical levels. This is clearly demonstrated where the increase in R^2 as a result of using all eight factors instead of six factors rises the average explanatory power by 7.8% (9.7%) with a p-value of 0.259 (0.050) in the 1990-94 (1995-99) period. This are set against peak R^2 values of 95.2% in the earlier time-frame and 95.9% in the later. When combinations of six or less factors are formed, however, significant informational differences are evident between the resulting benchmarks. F-Tests significantly reject null hypothesis of benchmark equality for all levels up to six factors (6F) in both periods, recording p-values that approximate nullity. As such analysis of individual factors and combinations thereof is strongly warranted.

As would be anticipated from the previous analysis of individual factors, the equally weighted index of managed fund returns takes the lead amongst single factor benchmark with R^2 values of 73.6% and 80.1% in the 1990-94 and 1995-99 periods, respectively. Coming next are the term and risk premium variables, as well as the equity market proxy. The remaining four variables representing interest rate and economic influences lie on the other side of the spectrum with R^2 values lying generally in the sub 5% area. Whilst the individual performance of these factors is relatively weak, they team up strongly with other factors, particularly the aggregate market factor. In fact, the leading pair of factors combines the aggregate market index with the interest rate proxy in 1990-94 and the lagged variant of this proxy in 1995-99. Although such combination substantially improves the information content of such benchmark, it too still falls significantly short of the peak with an R^2 gap ranging from 8.6% to 14.0%. However, it is now not the least surprising to find a three-factor benchmark comprising the aggregate market index and the two variants of the interest rate proxy to be the first benchmark that records an R^2 statistically indifferent from the peak (a gap of 6.6% and 6.2% for the two periods and corresponding p-values of 0.356 and 0.107). As a test of robustness, the most informative four-factor benchmark includes the same three factors, complemented by the equity market proxy. Finally, the leading combination of five benchmark factors again includes the leading quadruplet, now supplemented by the high yield return proxy. Overall these results not only assure the robustness of the three pre-selected factors in multiple benchmark settings, but also cast some doubt on a rather bold statement by Blake, Elton and Gruber (1993:383) who posited that studies measuring performance of fixed interest managed funds “would reach similar conclusions no matter which measure was used, as long as the measure contained a high-yield index”,

Turning attention now to the cross-sectional information efficiency results, similar conclusion can be made whereby on average more than six factors do not provide significant increments in the explanatory power. This is, however, once again teamed up with F-Test statistics, which indicate that for those benchmarks that incorporate six or less factors, informational performance is highly varied (F-Test probabilities approximate nullity on most accounts). First section of Panels B1 and B2 also presents the peak explanatory power of all eight benchmarks to reach 90.8% in 1990-94 and 93.3% in 1995-99.

In individual factor reviews performance of the equally weighted fund returns index again proves to be the highest, but not to the extent that would fail to reject a null hypothesis of equality with the peak. The equity market index alongside the risk and term premium proxies again perform strongly, with the line up at interest rate factors and economic fundamental proxies. Whilst factor pairs, triplets and quadruplets improve general performance of the benchmark, neither records difference against the peak that is insignificant at conventional levels. The first glimpse of such performance arrives with a five-factor benchmark that combines the aggregate market proxy with the interest rate factor and its lagged variant, equity index and the inflation variable. This benchmark records a reliable R^2 of 84.8% in the earlier period and 86.0% in the later. With p-values corresponding to the drop off from the peak standing at 0.081 and 0.064, respectively, we would be hard pressed to confirm this benchmark as performing ‘similarly’ to the peak. Looking at the runner-up five-factor benchmark which substitutes the inflation variable for the GDP growth proxy, the impact of economic factors on cross-sectional explanatory performance is clear. It is therefore not surprising that the leading six-factor benchmark includes both of these factors in addition to the variables previously established. Able to explain as much as 88.5% of fund returns variations in 1990-94 and 88.6% in 1995-99, this benchmark also fails to reject null of zero difference relative to the peak, with p-values standing at 0.408 and 0.227 respectively.

In summary, time-series tests concur with Blake, Elton and Gruber’s (1993) finding of empirical evidence that concludes “bond returns can be explained by no more than three, and possibly two factors”. Indeed, three factors chosen from two categories have proven to explain as much as 80.1% of variations in returns of fixed income managed funds. However, expanding the view to the second information dimension, the cross sectional part of the analysis shows that in fact as many as six factors are required to provide adequate results. These six factors, representing the aggregate movement of the bond fund market, the economic fundamentals, the impact of interest rates and the equity market influences, are therefore collectively selected as the most informative benchmark in this funds management sphere. It’s objectivity, however, is yet to be tested in a companion paper.

4.9 Test of Robustness for the Pre-Selected Composite Benchmark

We perform one further test of robustness for the information content of the selected factors. The selection process followed several steps that included picking a winner factor from each category, and then finding the most suitable combination thereof. In this section we shall confront a hypothetical argument whereby combining non-selected factors from one category with non-selected factors from another could produce a more informative result than the combination of winners. To this end we retest all alternatives for each of the factors that enter our pre-selected benchmark and find their temporal and cross sectional explanatory power. To make the exercise more manageable we take note of the fundamental pairing of factors within two of the categories. First, inflation and GDP growth have been inherently linked in the economic fundamentals category, as has been a pair of their estimation errors. Similarly, spot and lagged variants of the interest rate proxies have been closely tied together. Consequently, in this test we test seven aggregate bond market factors against two alternative pairs of economic factors, two alternative pairs of equity market proxies and two alternative pairs of interest rate proxies. Table 8 summarises the results.

Referring to the legend for the table it is immediately clear that the six factors as prescribed by the above analysis take the lead in both information dimensions, thus confirming their suitability. Indeed, p-values of the differences between various combinations show these six factors to have a lead that is significant relative to the first runner up at 1% level (with the exception of the cross-sectional results for 1995-99, where the p-value reaches 1.3%). It can be also noted that all successive combinations revolve around the two aggregate bond market indices based on the funds themselves, and secondly the alternative definitions of the equity market proxies.

Table 8: Comparison of Winning Factor Combinations

Presented below are the results of information content across time (Panel A) and in cross section (Panel B) achieved from combinations of benchmark factors according to the winning framework. Below is the legend of constituting factors for the four-digit COMBINATION code [ABCD]:

A (Aggregate bond returns, 1F)

1. Value Weighted Index of Fixed Interest Managed Funds
2. Equally Weighted Index of Fixed Interest Managed Funds
3. UBS Warburg Composite Index
4. Salomon Smith Barney WGBI Index
5. Datastream All Maturities Index
6. JP Morgan Bond Return Index
7. JP Morgan Bond Price Index

B (Economic variables, 2F)

1. Inflation + GDP Growth
2. E^{ε} (Inflation + GDP Growth)

C (Equity Market Returns, 1F)

1. All Ordinaries Accumulation Index
2. 500 Value Weighted Index

D (Interest Rates, 2F)

1. 90-Day Treasury Note Rate + Lagged Variant
2. Datastream GBI with one to three year maturities + Lagged Variant

PANEL A: Time-Series Winners

	1990-1994			1995-1999	
Combination	**R^2**	**Δ p-value**	**Combination**	**R^2**	**Δ p-value**
2112	93.9%		2112	94.9%	
1112	89.8%	0.000	1112	91.2%	0.000
2111	88.9%	0.003	2111	90.1%	0.000
2211	88.6%	0.110	2121	88.6%	0.000
2122	88.0%	0.064	1111	88.5%	0.432

PANEL B: Cross-Sectional Winners

	1990-1994			1995-1999	
Combination	**R^2**	**Δ p-value**	**Combination**	**R^2**	**Δ p-value**
2112	88.5%		2112	88.6%	
1112	86.1%	0.002	1112	87.1%	0.013
2111	86.0%	0.364	2211	86.7%	0.042
1111	85.4%	0.021	2121	86.5%	0.396
2121	85.4%	0.931	1111	86.1%	0.124

5. Summary

We have set out to find a performance measure for the fixed interest managed funds that is informative as well as objective. The choice of benchmark proves, however, to be a major influence on the final results. Starting with an investigation of information efficiency offered by various factor categories and various combinations of factors we find it critical to include a factor representing aggregate bond returns, a proxy for interest rates, economic factors and an index representing equity market returns for a benchmark to be informative both, across time and in cross section. In fact a benchmark consistently showing the greatest explanatory power comprises even after a multitude of robustness tests includes the Equally Weighted Index based on returns of managed funds, a medium term interest rate proxy such as the one to three year government bond index compiled by DataStream and the lagged variant thereof, an inflation variable coupled with an orthogonalised GDP Growth measure and finally an All Ordinaries Accumulation Index representing the movements of equity markets.

Finally, the consistency of the above results across the two time frames examined in this study suggests these conclusions are robust.

Notes

1. Sum of combinations: $\binom{7}{1}+\binom{7}{2}+\binom{7}{3}+\binom{7}{4}+\binom{7}{5}+\binom{7}{6}+\binom{7}{7}$ = 7 + 21 + 35 + 35 + 21 + 7 + 1 = 127

2. Models based on the Arbitrage Pricing Theory of Ross (1976) were formulated to explain the cross-sectional behaviour of returns on alternative bonds by pricing each of the factors contributing to the observed variation. See, also Elton et al (1995) for their application of APT to analysis of bond fund returns.

3. We examine the explanatory power indicated by R^2 in the context of different number of independent factors, as well as Adjusted-R^2 which already takes into account the loss in degrees of freedom as more independent variables are introduced.

4. For example, the *aggregate bond returns* category, m = 127 as previously calculate.

5. See also Elton, Gruber and Blake (1995) on their estimation of factor contributions in a more limited collection of benchmarks applied to the sphere of ME bond funds. In their analysis, however, the authors derive the weights directly from *averages* of factor betas, and are thus unable to attribute significance levels to the resulting weights.

6. It should be noted that the explanatory power offered by this benchmark might not be itself an absolute maximum, but rather be statistically indifferent from the absolute maximum.

7. On the basis of responses from various institutions we feel assured that the principal differences in definitions applicable to Australia and the ME lie in procedural methods of data compilation, leaving the substantive nature of these index counterparts equivalent.

8. Comparison of intercept, coefficient and R^2 produced t-statistics of 0.109 or less corresponding to p-values in excess of 0.9, showing not only that the statistics are insignificantly different, but giving us confidence at 10% level (or better) that the results are actually the same. Correlation coefficients are all in the order of 0.999 or higher.

9. Similar to the Australian series, both the raw GDP returns and the estimation errors therein are orthogonally transformed, separating their information content over and above that of the inflation series in the process.

10. We note this cross sectional explanatory power to be significantly higher for fund based indices in the sphere of fixed interest managed funds as compared to the sphere of equity managed funds. The subject of another paper

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